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District Engineer Work in the Philippines.

By WILLIAM GOLDSMITH.*

The Philippine Islands are divided by the Bureau of Public Works into engineering districts with a District Engineer and Assistants in each; these districts are administratively under the Chief of the Provincial Division reporting to the Assistant Director of Public Works. Although the area of the Islands is only equal to that of the New England States plus New York, yet much of the work is distant one or two weeks travel by boat and train from Manila. Because of this and the consequent difficulty of communication, it was found necessary to use five Division Engineers who constantly travel and report personally to the Manila Office.

The Provincial Division is the construction force, designs being prepared by the Division of Designs in the Manila Office from information furnished by the District Engineer.

Taking District No. 3 as a typical Engineering District in the Philippines, we find it consists of the Province of Pangasinan, with headquarters at Dagupan, 120 miles from Manila on the Manila & Dagupan R. R. Other districts contain more than one province, depending on available revenues; Pangasinan has an expenditure of about $200,000 per year for all purposes and ranks third among the 31 provinces in this respect; this is about as much as two or three smaller provinces have, and these would be combined to form another district.

Most of this money is spent in the concerted Good Road Movement, inaugurated by the present Governor-General, W. Cameron Forbes, while he was Secretary of Commerce and Police. In the expenditure the following rules are observed:

1. Practical identity of interest and concentration of efforts of the Insular and Provincial Governments upon the improvement of the road system.

2. Until the needs of the more thickly populated sections of the country have been met, the system will not include projects whose only merit is the development of the country, or which depend for future use upon possible immigration.

3. The maintenance of completed roads takes precedence over new road construction; plans for construction will include future maintenance.

4. Roadbed will be of durable type; no unsurfaced road will be built.

5. Materials used in bridge and culvert construction will be confined to concrete and stone or brick.

A PHILIPPINE MACADAMIZED ROAD AND SOME OF THE TRAFFIC UPON IT.

The principal vital and practical point in the road policy is the continuous system of road maintenance. We have a dry and a rainy season. During the rainy season 100 to 140 ins. of rain falls within a five month period, placing the lower roads in some provinces entirely under water for at least 24 hours once a year; these conditions and the poor quality of the stone available make the maintenance of these roads quite a problem. After two years trial of the "labor system" of road maintenance, the "Money System" was introduced. The Insular Government has in effect a contract with each province by which the province, in return for a varying allotment per capita of population, binds itself to permanently employ one caminero for each kilometer of surfaced road, to provide from 40 to 50 cu. meters of stone or gravel per year for repairs on each kilometer, and also to regulate the injurious narrow-tired vehicle traffic. The minimum expenditure required of the Province under this contract is $150 per kilometer per year. The "Caminero system," outlined above, was found imperative. Without it the roads would become impassable in one year and would disappear in five.

In Pangasinan Province an American foreman, having a motorcycle, is in charge of 90 kilometers of road maintenance and visits each section twice a week. Under him for each ten kilometers is a Filipino Capataz (assistant foreman) with ten camineros, one for each kilometer. Capatazes receive a "Road Book" in their own dialect which explains their duties minutely, with sketches to illustrate; it is the policy and intention to develop these Filipino Capatazes so that in a few years they can take the place of the American foremen now being used.

Contained in the "Road Book" are the following rules for camineros:

1.—Keep the crown in the road.
2.—Fill all the lower places to-day.
3.—Rake off all loose materials.
4.—Clean the ditches.
5.—Clean the culverts.
6.—Keep the road hard.
7.—Cut the brush and weeds.
8.—Cut small and poor trees.
9.—Keep account of all material.
10.—Make reports promptly.

Five rock depositories 200 meters apart are placed on each kilometer with a capacity for 5 cu. meters of gravel or crushed rock each; they are filled twice a year, at the beginning and close of the dry season; this is on account of

*District Engineer, Third District, Bureau of Public Works, Philippine Islands.

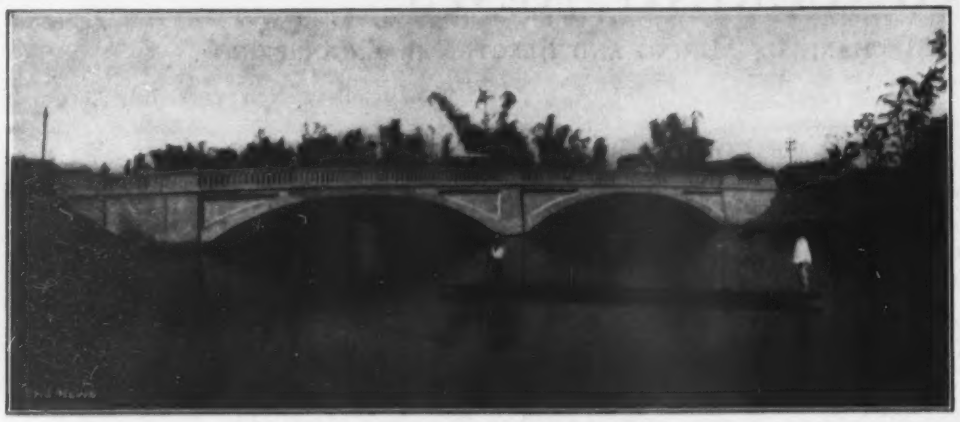

FIG. 1. BAYAOAS BRIDGE, PANGASINAN PROVINCE, P. I.
(Two 68-ft. span reinforced-concrete arches. Cost, including backfill approaches and macadam roadway, $20,000.)

SOME PHILIPPINE UNIT COSTS.

Cement, per barrel	$3.25
Steel reinforcing, per pound	0.046
Form lumber, Oregon pine, per M. ft. B. M.	40.00
Gravel at pit, per cubic yard	0.50
Crushed stone at quarry, per cubic yard	0.60
Transportation, native carts, ton-mile	0.15
Transportation, traction, ton-mile	0.10
American foremen, per day	$3.00 to 5.00
Carpenters, Chinese and Japanese	1.00 to 2.00
Carpenters, Filipino	0.50 to 1.00
Capatazes, Filipino	0.30 to 1.00
Labor, Filipino	0.25 to 0.40
Gravel roads, 18 ft. gravel way, 8 ins. gravel per mile	$2,400.00 to $3,200.00
Macadam roads, 18 ft. macadam, 8 ins. thick, per mile	3,000.00 to 4,000.00
Concrete, small bridges and culverts per cubic yard	$16.00

not being able to get the materials from the stream beds at other times. The cost of maintaining a kilometer of road per year is from $150 to $400.

The construction and maintenance of good roads has brought home to the Filipinos the many advantages they gain by them: they find twice as much rice can be hauled to market as formerly with the same animals and carts, that their cattle are less fatigued at the end of a trip, that transportation rates have been cut in two; in fact, they have learned the lesson of good roads and find that it directly benefits their pocketbook. Consequently instead of the old antagonistic spirit, we find them helping the work along and no longer complaining about the annual extra $0.50 road tax on all able bodied men of militia age, which is the means of securing one-third of the funds for this work.

In order to stimulate good road work in the provinces, the Insular Government gives a prize of $5,000 each year to the Province having "the best system of first-class roads"; Pangasinan Province won the prize last year.

All new Government buildings are also of permanent construction, reinforced concrete or hard wood being used exclusively; the Binalonan and Bayambang Schools are typical.

The metric system of measurements is used in all official documents. "Provided that in ordering articles from other countries the standard of weights and measures commonly used in such countries in selling such articles may be employed, provided further that in the purchase and sale of manufactured lumber the English system of weights and measures may be employed."

All road structures have a 16-ft. wide roadway and are designed to carry a live load of a 12½-ton road roller. The practice of building up road embankments above extreme flood levels has been done away with on account of the prohibitive costs necessary to provide sufficient waterways to pass all high waters. Instead, sufficient waterway is now provided for ordinary high waters and flood waters are allowed to pass over the road. Experience has shown that the water passing over the road does not do half the damage one would expect.

A regular system of cost accounting is in force and is working very satisfactorily. A few average unit costs in Pangasinan may be of interest as typical Philippine costs; see the accompanying table.

Although the number of contractors capable of seeing a job through properly is increasing, there are not sufficient to handle all the work. In consequence most of it is done by "administration" (day labor). This is where the District Engineer has his hands full. Skilled foremen are not available, making it necessary to develop discharged soldiers who have learned all they know of construction in the Philippines; the natives likewise are not accustomed to construction work, but they are easily trained. The main difficulty is in getting them to understand what is wanted; there are about 30 different dialects spoken besides Spanish, and it is mostly through signs and object lessons that the natives are taught to work properly. When a wheelbarrow was first introduced, two men, one at each end, promptly took hold and carried the barrow with its contents to the embankment instead of wheeling it; this is merely to illustrate that the most rudimentary methods of work must be taught them.

During the fiscal year 1909 there were constructed in this district 125 reinforced-concrete

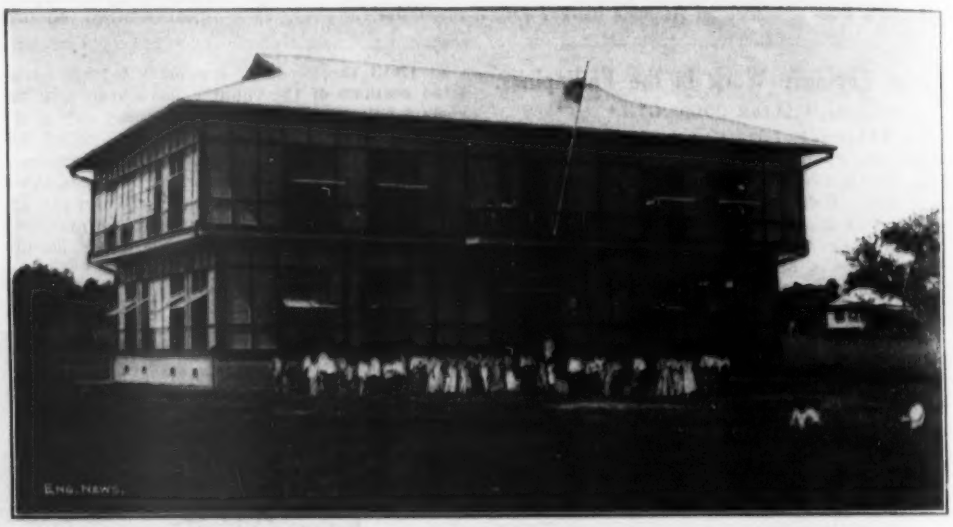

FIG. 2. BAYAMBANG SCHOOL.
(Built of hard wood throughout. Cost, $13,500.)

FIG. 3. PANTAL BRIDGE, UNDER CONSTRUCTION.

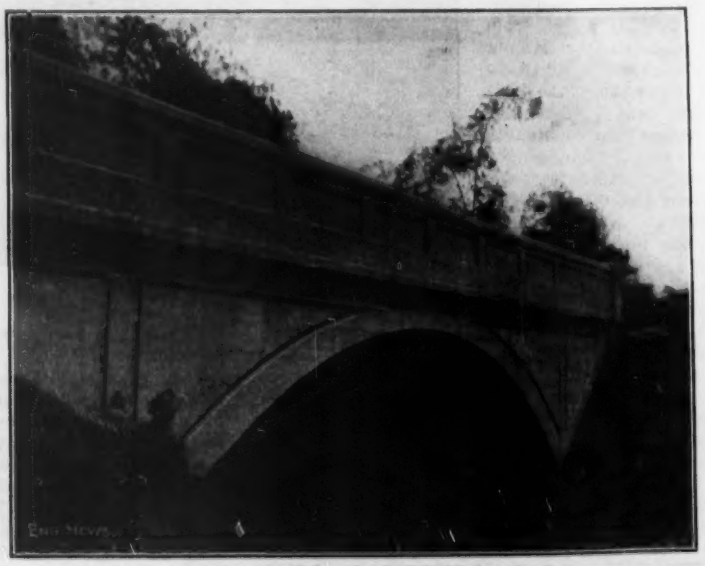

FIG. 4. ROSALES ARCH, STANDARD 40 FT. SPAN, COST $3,000.

culverts aggregating a total span of 702 lineal feet and 35 miles of first-class road. The work is going on during this fiscal year so that by July 1, 1910, this Province will have 60 miles of first-class road with reinforced-concrete culverts and bridges its entire length; this construction work will go on for years until the revenue of the Province will just be sufficient to maintain the constructed roads.

To give an idea of work in progress, a few works in this district completed or nearly completed this year may be described.

The Bayaoas Bridge is a two-span 68-ft. reinforced-concrete arch; it consists of four arch ribs supporting a reinforced-concrete floor; the arches rest on abutments and piers founded on piles; the cost, including backfill, approaches (2,000 cu. yds. of earth), road metal and engineering was $20,000. The Rosales Arch, 40-ft. span, reinforced-concrete was completed by "administration" at a cost of $3,000.

Reinforced-concrete culverts to the number of 56 have already been completed this year.

The Binalonan Bridge, a 90-ft. three-centered arch, is now under construction; also the Bolo River Bridge, a 50-ft. reinforced-concrete three-centered arch is being constructed by the same contractor.

The Pantal Bridge is practically completed; it spans a river 300 ft. wide at tide water in the town of Dagupan, and it is of reinforced concrete throughout; there are twelve reinforced-concrete pile bents, five piles to a bent; bents spaced 20 ft. c. to c.; a pier founded on a pile foundation is in the center of the span to lend stiffness to the structure; the piles are square 15 ins., reinforced by 4¼-in. steel rods with wire hoops. After being jetted and driven to their bearing of 20½ tons, the piles are cut off at mean tide, a solid panel, 7 ft. high, being constructed on top of them. Upon these pile caps rests the 20-ft. reinforced-concrete slab and girder. The piles are jetted down most of the way by water jets on either side of the pile; a steel cap and sand cushion being provided for driving the piles the last 6 ft. in order to determine their bearing. The piles are 45 ft. long; about 24 ft. in the ground through alternate layers of sand and river silt gives the required bearing. The girders and slab are cast entirely independent of the caps to insure against lateral strains being transmitted to the pile caps. Each slab has a tar-paper expansion joint. The Atlantic, Gulf & Pacific Co. have the contract for $20,000.

The Calmay Bridge, also in the town of Dagupan, is the same style construction, 630 ft. long, except that this has three piers with a steel draw span to allow large vessels to pass; the Atlantic, Gulf & Pacific Co. are also building this, for $44,000.

These are the first bridges of this type constructed in the Philippines, and from all indications the type will be extensively used throughout the Islands on account of the great saving over other types.

For the construction of gravel and macadam roads, crushed rock is towed 20 miles from the rock-crushing plant to the Lingayen-Dagupan road; here the rock is emptied into spreading dump carts and hauled by a traction engine to the point where it is needed on the road, a ten and a twelve-ton road roller being used in the rolling. This work is being done for $4,000 per mile.

In addition to his Insular Government duties the District Engineer has charge of all work authorized by the Provincial Board with whom he has direct dealings.

The Provincial Board consists of two Filipinos, elected every two years, and one American Treasurer, appointed by the Governor-General. He also has direct dealings with the municipal officials, who are all natives. Spanish is still the official language; but few can speak that well; still fewer can speak English. It is now possible, however, thanks to the work the schools have done, to get an interpreter in almost any town in the Islands, who will know his native dialect and enough English to be able to get along.

A District Engineer must cover so much territory that it is impossible for him to spend every night at his headquarters. For transportation he uses either a motorcycle, carromata (native carriage) or pony; he should always carry a canteen of boiled water with him as it is dangerous to drink unboiled water in the Philippines. On these trips there is usually an American in the towns he visits where he may stop and always be welcome for lunch or lodging.

When his headquarters are on the railroad or near an army post, he can get ice and just as good fresh food as is available in Manila; away from these points, canned goods, chicken, eggs and rice are the standbys. It costs about $40 a month for him to live comfortably in the Provinces, but this cost is counteracted by the saving on clothes which brings the cost of living to about on a par with country life in the United States.

FIG. 5. CONSTRUCTING A MACADAM ROAD IN THE PHILIPPINES WITH ROAD ROLLERS AND TRACTION ENGINES.

Long-Time Tests on Concrete in Sea Water.*

By A. POULSEN.†

Among the documents dealing with the work of the Congress, a pamphlet‡ has been handed in entitled "Cement in Sea-Water," giving information upon a series of tests which we commenced about ten years ago with a view to ascertain the principal causes which occasionally led to the deterioration of concrete work erected in the sea. The pamphlet has been presented to you by the Scandinavian Association of Portland Cement Manufacturers and you will find therein tabular statements and diagrams showing the results so far obtained. The limited time at my disposal does not allow me to enter into many details and I have given an abstract of the main points in this paper.

The cost of the tests in question are borne by the Association, and the tests are being carried out in conjunction with the Norwegian and Danish Hydraulic Works authorities and staff, whose assistance has proved of great importance and value. The program was drawn up at the time by a committee, the members of which are Messrs. Budi, Lund (since deceased), Morris-Haslinger, Wallin, engineers who were joined later by Mr. Kjellström, with myself as chairman, and entrusted with the supervision of the work as mapped out in the program.

I shall deal here with the pamphlet above alluded to, by taking seriatim the various points and enlarging upon them, as follows:

(a) The tests have been so carried out that the preliminary and the concluding operations only took place in the laboratory, a fact which enhances their practical value.

The tests in question may be said to be two-fold, in that they apply to cubes of mortar, about 3,500 in number and to concrete blocks, which number over 100, ⅜-cu. meters (23.5 cu. ft.) in volume. The blocks were made on the sea-coast off which they were to be deposited, i. e., at Thyboron, at the entrance of the Limfjord into the North Sea, near the town of Lemvig. The cubes of mortar have the usual surface of 50 sq. cm. (7.75 sq. ins.) to enable them to be broken in the machine in the laboratory; they were made in the laboratory. The committee acknowledge with thanks the assistance they received in this matter from the State Laboratory, Copenhagen.

From the laboratory, the test specimens were sent, for exposure to the action of sea-water and climatic conditions, to the Vardo harbor at the extreme northeast point of Norway; to Esbjerg harbor at the extreme southwestern point of Denmark, and to Degerhamn harbor, on Oland island, near the southeastern point of Sweden, in the Baltic sea. At Degerhamn care was taken that the test specimens should not be exposed to frost, by placing them sufficiently low under water level; the sea-water at that point has but a low percentage of salt (⅓%).

At Vardo and Esbjerg a series of specimens was similarly placed below the lowest sea level. A second series was placed at the average tide level, thus being exposed twice every day to climatic effects, especially to frost and the summer heat, which alternate with the sea-water action; the water at these points contains 3½% of salt. The specimens are thus caused to thaw twice a day during the winter months.

The tides at Vardo have a height of 4 m. (13 ft.) and at Esbjerg a height of 1.5 m. (5 ft.). The average temperature at both harbors and these may be considered as ice-free, is 7½° C. (45° F.), at Esbjerg and about 0° C. (32° F.) at Vardo; these are the temperatures both of the water and of the atmosphere.

From what we have already said, it will be seen that specimens of mortar were deposited for test in five different spots, each series containing about 700 cubes.

Long before our tests were commenced, it had been noticed that concrete work had to a large extent been deteriorated at Esbjerg and Vardo. The sets of specimens placed at both these spots were exposed to actions so pronounced and so different as regards their likely effect, that it was hoped they would yield most precise results. With reference to Degerhamn, where the climate is equal to that of Esbjerg, a very slight effect only was anticipated, the specimens being at a good depth in sea-water having but a low percentage of salt.

Concrete tests of a similar nature have also been made at a place where the use of concrete had given unfavorable results. The concrete blocks are there placed

*Report presented to the Fifth Congress of the International Association for Testing Materials, Copenhagen, 1909.

†Chief Engineer of the Danish State Hydraulic Works.

‡Abstract of the pamphlet "Cement in Sea-Water." Report on the trials commenced in 1895 on the recommendation of the Society of Scandinavian Portland Cement Manufacturers by A. Poulsen, Copenhagen. E. & F. N. Spon, London.

in a groin which forms part of the dike on the western coast of Jutland, pier 50. The average temperature of the water and the atmosphere is exactly the same as that of Esbjerg, about 7½° C. (45° F.). The tides, however, are less pronounced, being 0.5 m. (19 ins. only).

(b) The cases built to take the test specimens have given complete satisfaction: their object was to protect the specimens against becoming damaged by shock, while allowing all physical actions to have full play.

The results aimed at might easily have been compromised by the means taken to carry out the tests; fortunately, the success of the device was complete. Each case contained 77 cubes, and we were able to lower the specimens and to raise them out of the water at the expiration of the time appointed, i. e., at the expiration of 3 and 6 months, 1, 2, 4, 6 and 10 years, without the loss of a single cube, although some were cracked and others had lost their shape completely.

(c) The marking of the test specimens by colored glass in the shape of beads, or fragments of glass, to indicate composition and class of cement, has been entirely successful.

We followed this method of marking by glass beads not only for the blocks, but also for the cubes of mortar. Some specimens could not have been recognized had any other method of marking been used, whereas their origin was most accurately traced by means of the beads.

For the mortar specimens, a class of Portland cement was selected from each of the three Scandinavian countries: Denmark, Norway and Sweden. For comparison, a British Portland cement was also taken, and also a French hydraulic lime. Test pieces were made using each of these classes of cement in the following proportions: 1:3, 1:2, 1:1 and 1:0 (pure cement), four cubes of each proportions, using "normal sand" of Bornholm. A series was also made, using sand from the Thyboron sand-hills and Aalborg cement.

We also carried out a few trials with additions to the Portland cement and with other mortars, including: (1) trass, (2) infusorial earth, (3) a silicate with an addition of "Lomma," (4) slag cement, (5) a special "Dania" cement, (6) a "sand cement," (7) Kinniple concrete, (8) hollow "Monier" blocks, (9) santorin* and cement, (10) santorin and lime, (11) pozzolana and cement, and (12) pozzolana and lime.

Besides these blocks formed of different kinds of cement, we made blocks 2 × 12 ins. in the proportions 1:3 and 1:2, using one and the same cement and sands of three different degrees of fineness mixed together.

These blocks were all manufactured, using fine sand-hill sand and shingle of the Thyboron seashore, the mortars having the proportions 1:3, 1:2 and 1:1, also in some cases 1:2.5, the proportion between the shingle and the mortar corresponding for all these mortars to that of the mixture 1:2 with 4 of single.

The total number of blocks thus exceeded 100.

(d) When the program of the tests was drafted the dates at which the results were to be ascertained should have been fixed at longer intervals during the first years, so as to be able, later on, to count upon a larger number of results.

It has been stated above, under (b), that the raising of the cases was timed to take place after 3 and 6 months, 1 and 2 years, etc. A period of ten years has elapsed, and there are still at each place two cases, which are to be raised after a total period of 15 and 20 years. We may state for the guidance of those engineers who may wish to carry out similar tests, that in this respect a better arrangement could have been made.

(e) The chemical actions of salt-water are not alone able to deteriorate mortar; Portland cement appears to be almost intact.

Among the actions to which the cubes of mortar are exposed, the chemical action should have been most clearly shown by a comparison between the results of the exposure below the sea lever at Degerhamn and those of the exposure in deep water at Esbjerg, there being between the two places only a difference in the percentage of salt in the water 3½% and ½%.

Mr. Czarnomsky has stated that in the Black and Caspian seas, salt has a marked effect on concrete. The percentage of salt in both the latter seas, and the temperature of the atmosphere especially, are much higher than in Scandinavia. At those two places, therefore, the salt has a more marked effect, while on the Scandinavian coasts other actions, especially frost, prevail.

(f) On the other hand, the Teil lime was found to be subject to great chemical variations. The analysis at Vardo tends to show that a mechanical action may have hastened a simultaneous chemical decomposition.

As is well known, the Le Teil lime has acquired a great renown in the French Mediterranean ports; it is there considered quite satisfactory and is almost exclusively used for constructions in the sea. The same for Italy in regard to pozzolana and lime mortars, and this notwithstanding the high percentage of salt in the Mediterranean waters, 4%. Although these materials acquire after an exposure of about 20 years to the action of the sea a consistency similar to that of chalk, they are used with advantage.

*A clayey sand containing about 70% silica found in the island of Santorin, Greek Archipelago.

In our more northern countries, Teil lime deteriorates relatively quickly, and, besides, a chemical effect has been noted; this is explained by a primary action of frost which by causing cracks on the surface, accelerates and increases the chemical action. Portland cements which acquire more rapidly a sufficiently high resistance to better withstand the mechanical effect of frost, appear for this reason to be, comparatively at all events, free from chemical actions.

In some cases, a granite facing with a grouting carefully maintained might act as a protection.

The poorer kinds of mortar were not sufficiently sheltered. They cracked and a white mass issued from the cracks. In some instances we found what are styled "tulipes de beton," strange formations which, however, do not proceed from the test specimens, but from a groin of the dike to the north of Thyboron.

(g) The deterioration of the mortar tests specimens was due mostly to the mechanical effect of frost.

In comparing the test specimens from Vardo with those from Esbjerg, and specially those that were placed at the average sea level, a very great difference is found, although the water at both these harbors contains practically the same proportion of salt, 3.5%. There is, however, a considerable difference in the climate of these two harbors, situated at a distance from each other, the average temperature of the atmosphere and of the water being 0° C (32° F.) at one place and 7½° C (45° F.) at the other.

We have here the most important result of our tests, i. e., the predominating effect of a cold climate. While at Esbjerg and at Degerhamn the test specimens kept pretty satisfactory for ten years, only a few from Vardo have revealed a high resistance in the crushing test carried out at the laboratory, a further proof of the supposition that the disintegration of the mortar cubes was not due to an internal chemical action, but to a mechanical effect on the surface.

(h) The deterioration of concrete blocks is also explained by climatic effects.

The blocks have been placed at Thyboron only; no comparison is, therefore, possible. It is hardly possible either, although an attempt has been made to do so, to note the chemical results produced. The analyses have shown, both in regard to the blocks and mortar cubes, that the amount of oxide has decreased. In certain instances, especially in the Teil lime, the proportion of magnesia and sulphuric acid has increased. There has always been found an increase in the quantity of chlorine which generally and from the analyses made for this, has no chemical connection with the alkali.

It should be remarked, however, that accurate analyses of a mortar, and more so of a concrete, are rendered very difficult by the foreign bodies which are introduced with the sand and the shingle; for this reason it is practically impossible to obtain exact figures. The appearance of the blocks is therefore the more reliable means for estimating deterioration.

(i) The 1:3 mixtures of mortar is too poor for use in the sea in Scandinavia.

Here, the word "sea" implies normal sea-water containing 3.5% of salt; in the Baltic, weaker mixtures can no doubt be used if they be protected against frost.

In sea-water, specially at Vardo, our tests showed the 1:3 specimen of mortar to have much less durability; among the concrete blocks placed at Thyboron, those with 1:3 mortar were almost all destroyed after ten years.

(j) The sand used in mortars should be mixed sand of different degrees of fineness, the greater portion, however, being fine sand; specimens having the denser mixture were not those which lasted longest.

The coarsest said in the mixtures is formed of particles of the size of grains of corn or barley; the finest is that of the local sand-hills and there is used also a sand of intermediate fineness. The denser mixture contains ⅓ of fine and ⅔ of coarse sand, with 24% water; it contains no sand of the intermediate grade. The mixture of ⅓ fine with ⅔ average fineness was found superior to all others in tests made elsewhere. In our country the results bear upon a mixture having a larger proportion of fine grade (about half) and containing but coarse and fine sand.

(k) The addition to the cement of a material crushed fine (trass, or ordinary sand) is advantageous.

Our tests have confirmed former results, to the effect that mortar can be improved by adding to it various substances, crushed as fine as the cement itself. For us, however, this point has not the value which attaches to it in those countries where trass, or pozzolana, is found, or where slag is produced. We have ascertained the value of ordinary sand, crushed with the cement ("sand cement"), and we have also made a test with an addition of Danish infusorial earth, the cheapest addition for us, the result of which is as yet doubtful.

In conclusion, I may add that the tests in question mapped out to cover a period of twenty years have, so far, only covered half that period. The results, therefore, are not yet complete and cannot be considered as final.

The Effect of Included Sulphuric Acid on the Strength and Behavior of Portland Cement Exposed to Sea-Water.

The Argentine Republic some years ago prescribed in its official tests for Portland cement, that all cement intended for use in marine work, especially in sea-water, must not contain more than 1% of sulphuric acid. This restriction was not considered just by the German Portland cement manufacturers, who do a large business in South America, and they had a series of tests made at the Royal Testing Laboratory, near Berlin, to demonstrate that a certain amount of sulphuric acid, above 1%, could be included in cement, without harming a concrete made therefrom, even though that concrete were used in sea-water. These tests were briefly reported, upon by Mr. R. Dyckerhoff at the meeting of the International Association of Testing Materials last September. His report, with the metric units transposed to those used in this country, is as follows:

Cement A was a Portland cement which is applied to all sorts of purposes including those of marine structures. Cement B was a Portland cement of a kind that is specially supplied for marine structures. The former has a percentage of sulphuric acid of 1.28%, the latter a percentage of 0.56% In the cases of both cements the percentage of sulphuric acid was raised to 2.5 by suitable additions of plaster of Paris.

With these four cements, cubes of a sectional area of 7.75 sq. ins. were produced in mixtures of 1 of cement to 2 of sand and of 1 of cement to 4 of sand, respectively, for strength tests to be continued up to a ten years' hardening in fresh water, sea-water, and open

TABLE SHOWING EFFECT OF INCLUDED SULPHURIC ACID ON STRENGTH OF CEMENT MORTARS HARDENED IN AIR, FRESH WATER AND SEA WATER. TESTS MADE AT THE ROYAL LABORATORY FOR TESTING MATERIALS, GROSS-LICHTERFELDE, GERMANY.

(Compression Values in Lbs. per Sq. In. on 2¾-in. Cubes.)

Proportions by weight.....	1 cement and 2 sand.			1 cement and 4 sand.			1 cement and 2 sand.			1 cement and 4 sand.		
Immersion up to time of test.	Fresh water.	Sea water.	Open air.	Fresh water.	Sea water.	Open air.	Fresh water.	Sea water.	Open air.	Fresh water.	Sea water.	Open air.
Kind of cement	Cement A Unmixed; Percentage of Sulphuric Acid 1.28.						Cement A; 2.77% addition of Plaster of Paris; Percentage of Sulphuric Acid = 2.5.					
Age 28 days..	8,720	8,150	9,240	3,810	3,430	4,140	8,760	8,360	10,380	4,930	4,200	5,520
Age 1 year..	9,480	8,820	12,170	3,680	3,570	5,760	12,430	10,190	11,680	4,930	3,360	5,580
Kind of cement	Cement B Unmixed; Percentage of Sulphuric Acid, 0.56.						Cement B; 4.36% addition of Plaster of Paris; Percentage of Sulphuric Acid = 2.5.					
Age 28 days..	3,600	3,900	4,300	1,530	1,610	2,040	4,100	3,620	4,910	1,590	1,440	2,040
Age 1 year...	5,200	4,150	6,280	2,380	1,890	3,560	6,160	4,840	8,520	2,710	2,120	4,360

		Cement A.	Cement B.
STANDARD SAMPLE (1:3; 28 days in water)	Tensile strength (lbs. per sq. in.)	401	287
	Compressive strength (lbs. per sq. in.)	5,180	2,400
	Residue on 180 mesh to inch screen	15.1%	36.2%
	Residue on 80 mesh to inch screen	2.0%	7.8%
CHEMICAL COMPOSITION.		%	%
Analysis calculated on calcined condition	Loss by calcination	0.65	1.58
	Insoluble residue	0.11	0.10
	Silicic acid	22.17	22.55
	Iron oxide	1.98	2.50
	Alumina	6.18	8.35
	Lime	67.20	64.11
	Magnesia	0.92	1.05
	Sulphuric acid (SO_3)	Residue	Residue
	Alkalis	1.28	0.56

air, respectively. The results for the first year are given in the accompanying table.

On account of its low percentage of lime and of the coarser grinding, Cement B gave lower absolute strength values than Cement A, in the standard sample and, consequently also, in the experiment.

For all mortars, the power of resistance to sea-water is weaker than that to fresh water. In spite of its low percentage of sulphuric acid, Cement B shows less strength in sea-water than Cement A.

The increased percentage of sulphuric acid occasioned by the addition of plaster of Paris produces an increase of strength both in fresh and in sea-water. Thus the durability of the cement in sea-water is not influenced unfavorably by the high percentage (2.5%) of sulphuric acid.

Further, concrete stones of 1 cu. yd. content were made in all four cements mixed in the proportions 1 of cement to 2 of sand and 3 of broken granite stones, and, after six months hardening in air, were immersed in the jetties, where they were exposed to chemical action and to the full brunt of the waves of the North Sea.

In a second series of experiments, slabs of 20 × 20 × 3 ins. in mixture of 1 to 2 and 1 to 4 were made, and, after hardening periods of four weeks and six months respectively, were laid on the pier in the shallow estuary, where they were exposed to ebb and flood. . . . These plates were exposed to the action of the water of the North Sea. It was found that the plates of the Cement B (described in table) showed cracks and clefts, while the plates of Cement A remained absolutely intact.

Also larger blocks made of 1 of cement to 2 of sand and 3 of broken granite behaved in the same way as the plates. The blocks of the cement B were attacked in such a manner that the granite was laid bare. In view of the results obtained, it can fairly be said that the requirement of the Argentine Republic, to the effect that only cements poor in sulphuric acid be used for sea-water structures, is a very mistaken one.

A Plea For Standardization in Electrical Equipment of Railways.*

By GEORGE WESTINGHOUSE,† Pres. Am. Soc. M. E.

Large sums have already been spent in the electrification of portions of standard steam railways in England, continental Europe and America, and there is now available a fund of information of inestimable value to guide those charged with the selection of an electrical system for railway operations.

Believing unreservedly that the increased capacity of a railway and its stations, the economies of operation, and other advantages will bring about gradually the systematic electrification of steam railways, my wish is that the progress of the art may not be hampered and such electrification of our main lines delayed or rendered unprofitable by mistakes which experience, judgment and foresight may enable us to avoid.

It is my intention in this paper to direct attention to the necessity for the very early selection of a comprehensive electrical system embracing fundamental standards of construction which must be accepted by all railway companies in order to insure a continuance of that interchange of traffic which, through force of circumstances has become practically universal, to the great advantage of transportation companies and of the public.

Having been identified with railway operations for over forty years, and with the development of the electrical industry for twenty-five years, I feel that the time is ripe for such a selection unless we are willing to regard with complacency the extension of the existing diversified systems and the creation of conditions which will prevent the general use of the most practical methods of operation.

Indeed, the tendency seems to be toward diversity rather than unity, since different types of third-rail construction have been adopted even for the several continuous-current systems in and about New York City, which renders interchange of cars or locomotives difficult or impossible.

The fundamental interchange requirements for electrically operated railways [additional to those governing present railway car construction for free interchange—Ed.] are:

A supply of electricity of uniform quality as to voltage and periodicity.

Conductors to convey this electricity so uniformly located with reference to the rails that, without change of any kind, an electrically-fitted locomotive or car of any company can collect its supply of current when upon the lines of other companies.

Uniform apparatus for control of electric supply whereby two or more electrically-fitted locomotives or cars from different lines can be operated together from one locomotive or car.

Three important electrical systems for the operation of railways have been put into practical operation, all using alternating current in whole, or in part. These systems are:

The continuous or direct-current system, usually spoken of as the "third-rail" system, which employs alternating current for transmitting power when the distance is considerable.

The three-phase, alternating-current system with two overhead trolley wires.

The single-phase alternating-current, high-tension system with a single overhead trolley wire.

Railway Motors.

Essential requisites in a railway motor are that it shall start its load and quickly accelerate it to the required speed, and that it shall operate continuously at any desired speed, or speeds. Railway conditions make desirable speeds varying from the slowest to the highest schedule speeds for regular operation, both for the movement of freight and passengers, and for making up time.

The steam locomotive, which is limited in power by its boiler capacity, is capable of continuous operation at any speed up to the maximum, but the maximum speed in a given case depends both upon the length of the train and the grade of the track. It automatically slows down when ascending a grade, so that the actual horsepower developed does not vary greatly at different speeds. The limitation of the capacity of the electric locomotive is not the power available, as in the case with the steam locomotive, but in the capacity of the motors, and is usually fixed by the heating of their coils. An electric locomotive may safely develop for a short time an output which far exceeds its normal continuous capacity. The power and speed characteristics of electric locomotives therefore differ from those of steam locomotives.

The three types of electric motors have certain fundamental differences in speed performance which are important factors in determining the advantages, disadvantages and limitations of the several systems.

THE DIRECT-CURRENT MOTOR.—The characteristics of the direct-current series railway motor are well known. It automatically adjusts its speed in accordance with the load, running more slowly if the weight of the train be greater, or the grade steeper. The speed with a given load, however, is definite; it is dependent upon the voltage applied to the motor and cannot readily be varied. It is true that the speed can be decreased by inserting a resistance in the motor circuit, but this is wasteful and is inadmissible except as a temporary expedient. It is true also that the motors may be connected in series, thus dividing the pressure between two motors, and thereby reducing the speed one-half; or if among four motors, to one-quarter speed.

As the system of current supply involves a fixed voltage, it is obvious that for emergencies no speeds much above the maximum speed determined in the construction of the motor can be obtained. Furthermore, on account of the high cost involved in maintaining a practically constant voltage throughout the system, the voltage supplied to the motors often decreases considerably at the end of long lines, at the time of heavy load, thereby further reducing the speed attainable. It often happens in railway service that a locomotive should be operated somewhat above the normal speed, and sometimes a locomotive designed for freight service has to be pressed into passenger service. In such cases the speed with the direct-current locomotive would be considerably less than that necessary to maintain the schedule speed. A special form of field control can be used, in certain cases, for varying the speed, although this has so far been utilized to a very limited extent.

THE THREE-PHASE MOTOR.—On the three-phase system, the motor is inherently a constant-speed motor; it runs at approximately the same speed at light load and at full load; it runs at nearly the same speed up a grade as on level track, although the horsepower required on the grade may be several times that on the level. Conversely, it can run no faster on a level than it can climb a grade. In order to give a lower speed, however, the motors may be arranged upon the locomotive in pairs in a manner equivalent to the arrangement of two continuous-current motors in series, just described. Motors may also be arranged for two or more speeds, but this involves some complication in windings and connections. In all cases lower speeds can be secured by the introduction of resistances which increase the losses and lower the efficiency. In no case can the speed in any of the arrangements of motors be appreciably higher at very light load than it is at full load.

The motors are of the induction type without commutators and their inherent limitations, and are of relative simplicity in construction. The current is usually supplied at 3,000 volts from two overhead lines through two sets of current collectors.

With three-phase motors as now constructed and arranged upon locomotives, it is possible with no additional complication so to utilize the motors when locomotives are moving trains upon a descending grade, that they become generators and return current to the line, a feature of value in certain mountainous districts but not of controlling importance in the selection of a universal system.

THE SINGLE-PHASE MOTOR.—The single-phase railway motor is a series motor with speed characteristics very similar to those of the direct-current motor, as the speed at a given voltage is greater or less, depending upon the load. The speed with a given load is also greater or less, depending upon the pressure applied to the motor; and this is not limited, as with direct-current motors, to that supplied by the circuit, and to one-half and one-fourth of that pressure, but is capable of adjustment to any desired degree of refinement by means of auxiliary connections from the secondary winding of the transformer on the locomotive, which is necessary for reducing the line voltage of 11,000 volts to the lower voltage required by the motors. Not only may numerous voltages less than the normal be arranged for lower speeds, but higher voltages can be provided to make possible speeds considerably above the normal. In this simple manner a wide range of efficient speed adjustment is secured which is impossible with other systems.

Like the throttle lever of the steam locomotive, the control lever of the single-phase locomotive may be placed in any one of its numerous notches to maintain the required speed. This facility of efficient operation over a wide range of speed and power requirements is one of the especially valuable features of the single-phase system. This difference, however, may be noted: the ability of the steam locomotive to maintain its speed continuously with heavy loads depends upon the capacity of the boiler; on the other hand, the electric locomotive has an ample supply of energy available, drawn from a large power-house, and the limit of its endurance is determined by the safe temperature of the motor.

The question of determination of the frequency for use on single-phase railways is one of very great importance. Twenty-five cycles is in general use for power transmission purposes and has been adopted by nearly all the single-phase railroads now operating. The Midi Railway of France has adopted 15 cycles. The lower frequency permits of a marked reduction in the size of a motor for a given output, or conversely of a considerable increase in output from a motor of given dimensions and weight. Three-phase installations in nearly all cases employ approximately 15 cycles. The choice of frequency is one of the most involved, difficult and important problems now presented for solution.

SUMMARY.—Locomotives equipped with each of these motors have been in successful operation and have demonstrated their usefulness, capacity and reliability in practical railway service. The three-phase motor, having a definite constant-speed characteristic, is particularly adapted to certain conditions; but, on the other hand, it has a less general adaptability to the ordinary varying conditions of railway operation. The single-phase motor has a facility of voltage control which gives an efficient means of speed adjustment, and is in this particular superior to other systems. The relative weights and costs of the several types of motors, and of the locomotives designed to accommodate them, depend upon so many conditions that comparisons must necessarily be general. It will be found, however, that these differences in locomotive cost are in many cases more than offset by the cost of the other elements in the electrical system.

The control apparatus for all types of locomotives has been developed so that it is reliable and convenient in operation. For each system a small master controller serves to operate by auxiliary means the necessary electric switches for the control of the motors of one locomotive, or to operate simultaneously as a single unit the motors on two or more locomotives or cars in a train.

The three types of railway motors, and the three respective systems for conveying power from the generating station to the locomotives, have all successfully demonstrated their ability to operate railway trains.

Requisites for a Universal Electric System.

In selecting a proper electrical system for railway operation, it will probably be generally conceded that the following elements are of prime importance:

a. The electric locomotives should be capable of performing the same kinds of service which the steam locomotives now perform. This will be most readily secured by electric locomotives which can practically duplicate the steam locomotives in speed and power characteristics. This includes a wide range of performance, embracing through passenger service at different schedule speeds; local passenger service; through freight service in heavy trains; the handling of local freight by short trains; and a variety of switching, terminal and transfer movements. This naturally calls for wide variation in tractive effort and in speed, both for the operation of different kinds of trains, and also for the operation of the same train under the varying conditions usually incident to railway service.

b. The electric locomotive should be capable of exceeding the steam locomotive in its power capacity. It should be able to handle heavier trains and loads, to operate at higher speeds, and in general to exceed the ordinary limits of the steam locomotive in these regards. The readiness with which several electric

*Brief abstract of a paper entitled "The Electrification of Railways; An Imperative Need for the Selection of a System for Universal Use," to be read at the Joint Meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, at Birmingham and London, July 26-29, 1910.

†Pittsburg, Pa.

locomotives can be operated as a single unit enables any amount of power to be applied to a train.

c. The electric system should adapt itself to requirements beyond the ordinary limitations of the steam locomotive in small as well as large things. It should be adapted for use on branch lines, and for light passenger and freight service similar to that so profitably conducted by interurban electric roads, which in many cases run parallel to steam roads, not only taking away the traffic of the steam roads, but building up a new and highly profitable traffic, both in passenger and in express service.

d. A universal electrical system requires that power should be transmitted economically over long distances and supplied to the contact conductor. The system should utilize the most highly perfected apparatus for

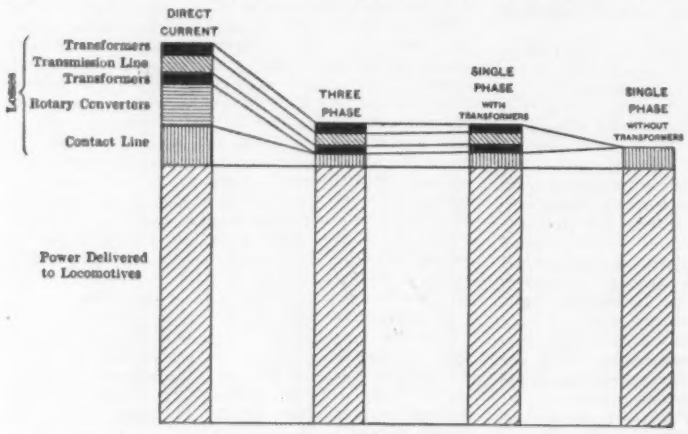

FIG. 1. DIAGRAM OF COMPARATIVE POWER LOSSES BETWEEN POWER-HOUSE AND LOCOMOTIVE FOR DIFFERENT ELECTRIC SYSTEMS.

the electric transmission of energy and its transformation into suitable pressures for use.

e. The contact conductor in an ideal system should be economical to construct, both for the heaviest locomotives where the traffic is dense, and for light service on branch lines. It should impose minimum inconvenience to track maintenance; should give minimum probability of disarrangement in case of derailment, or in case of snow and sleet, and should in general be so placed and constructed as to give a maximum assurance of continuity of service.

The use now made of electricity in steam railway service has been brought about, generally speaking, through compulsion. The steam locomotive has reached its limitations and has been found unsuitable and inadequate in tunnels or in terminal service. Even where other considerations may have been controlling, the problem has usually been a specific one of electrifying a relatively small area. The problem has been solved by considering those factors which were of immediate importance, without giving weight to uniformity with other systems or of extension.

Now the natural course of development will be the extension of these limited zones, until after a time they meet. Then there will arise great inconvenience and expense if the systems are unlike. For the present it may be a matter of little moment whether different systems have their contact conductors in the same position, or whether the character of the current used is the same or different. As previously stated, in the early days of railroading, it was of little consequence whether the tracks of the different systems in various parts of the country were alike or unlike, but later it did make a vital difference, and the variation resulted in financial burdens which even yet lie heavily on some railways. It is this large view into the future of electrical service which should be taken by those responsible for electric railway development.

The Future of Electrification of Railways.

The complete electrification of a railway will necessitate a rearrangement of ideas and practices in regard to operations. Coaling and watering places will not be needed; passenger trains will be differently composed, some classes being of less weight; and they will operate more frequently, thus promoting travel; other trains will be heavier than at present, or will operate at higher speeds; and branch lines, by the use of electrically fitted cars, can be given a through service not now employed.

The movement of freight will undergo great changes, due to the fact that electric locomotives can be constructed with great excess capacity, enabling them to move longer trains at schedule speed on rising gradients.

The large percentage of shunting operations due entirely to the use of steam locomotives will no longer be required.

The railway companies can combine upon some cooperative plan for the generation of electricity, thereby effecting large savings in capital expenditures; and can utilize their own rights of way for transmission of the current, not only for the operation of trains but for many other useful purposes.

Notwithstanding the fact that great strides have already been made in cheapening the cost of generating electricity by steam engines, I foresee, from the progress made in the development of gas and oil engine power, a still further reduction in cost which will accelerate the work of electrifying existing railways.

One important aspect of this great question will engage the thoughtful consideration of every government, namely, the military necessity for uniform railway equipment in time of war.

There will be serious difficulties to surmount in the selection of a general system. There naturally will be arguments in favor of one or another of the systems now in use and the inclination of those who have adopted a particular system to advocate its general use. There will be enthusiastic inventors, and there will be many advocates of the common view, namely, that there is room for several systems and that each system will best meet the requirements of a particular case. There will be those who give undue weight to some feature of minor importance, such as a particular type of motor or of locomotive, instead of giving a broad consideration to the whole system, and recognizing that, in the general problem of railway electrification, facility and economy in transmitting power from the power-house to the locomotive, are of controlling importance.

Were there now only one system to be considered, there would be a concentration of the energy of thousands on the perfecting and simplifying of the apparatus for that system, to the advantage of railway companies and of manufacturers.

In conclusion, I can only repeat, and earnestly recommend to the serious consideration of railway engineers and those in authority, the pressing need of determining the system which admits of the largest extension of railway electrification and of a prompt selection of those standards of electrification which will render possible a complete interchange of traffic in order to save expense in the future and to avoid difficulties and delays certain to arise unless some common understanding is arrived at very shortly.

APPENDIX.

COMPARISON OF SYSTEMS OF ELECTRIFICATION.*

COMPARATIVE LOSSES.—Fig. 1 shows the comparative losses between the generators and the locomotives for each of the three systems, based on a class of service where the input to the locomotives by the several systems is practically the same.

As some kinds of service render one type of motor with its auxiliary apparatus and control more efficient, while under other conditions it may be less efficient, this variable element has been eliminated by assuming the same power delivered to each locomotive as a basis for a general comparison of the transmission losses.

*Five appendices accompany the original paper. Only one of these is abstracted here.

The total height of each column in the diagram indicates the total power delivered by the power-house in the system designated. The height of the long portion at the lower part of each column indicates the amount of power which reaches the locomotive.

It will be noted that the large losses in the rotary converters appear only in the direct current system. The larger single-phase column shows the losses where the distances are such that it is necessary to use a transmission line and transformer. The smaller single-phase column represents the trolley wires connected to the generators without any intervening transmission line or transformers. The loss of power between power-house and locomotives is relatively small as compared with that in any of the other systems. This is the condition on the New York, New Haven & Hartford R. R., where

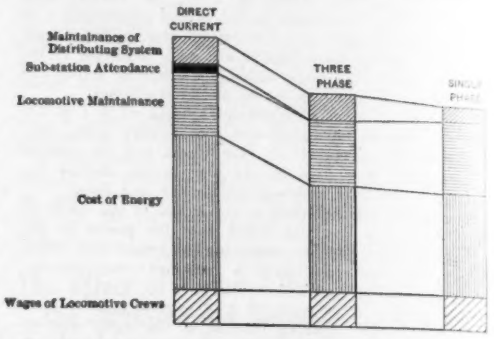

Fig. 4. Comparative Operating Costs for the Pusher Grade Represented by Fig. 3.

the power-house is distant nearly 20 miles from one end of the line.

COMPARATIVE FIRST COSTS.—Fig. 2 shows the comparative estimates prepared a few months ago of first cost in a particular case for electrification by the direct-current system and by the single-phase system. In the preparation of these estimates the three-phase system was not called for, and as no estimate covering it has been prepared, it is not included in the present comparison. The estimates cover a single track line 100 miles long involving both freight and passenger traffic in both through and local service and include 20 locomotives.

The costs for power station include only the machinery and building and do not include cost of hydraulic development. It will be noted that the considerably less cost of the single-phase system in this case is due largely to the lower cost of contact line and substations.

Fig. 3 shows the comparative estimates of first cost for the three systems for pusher service on mountain grades in a particular case involving the use of twelve locomotives. The total length of line is 32 miles, part of which is single track, part double track and part three tracks. In addition to the main line there is a large yard to be electrified, there being a total of 90 miles of single track. The location of the power station was fixed by non-electrical considerations. The distances were such that substations were required when

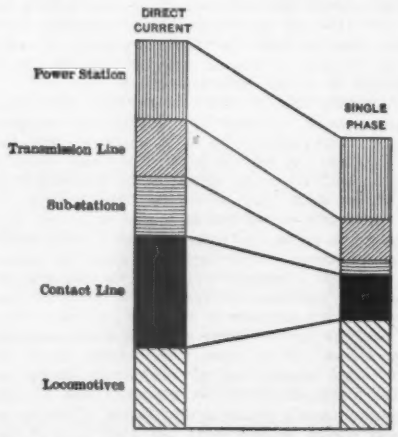

Fig. 2. Freight and Passenger Service, 100-Mile Railway.

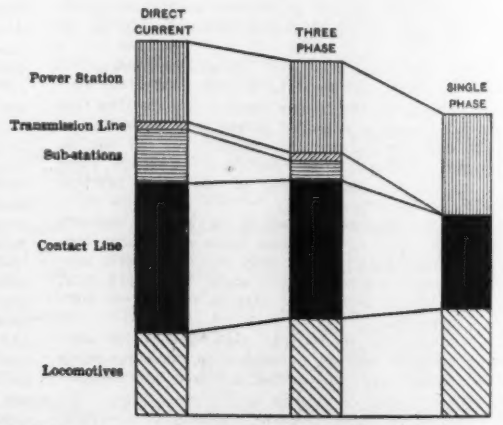

Fig. 3. Pusher Grade, 32 Miles.

FIGS. 2 AND 3. COMPARATIVE FIRST COSTS OF ELECTRIC EQUIPMENT IN TWO SPECIAL CASES.

either direct current or three-phase current was assumed, but the entire system could be fed direct from the generators if single-phase current was used.

It will be noted that in this case the omission of substations and transmission effects a very considerable saving in favor of single-phase as well as the usual large saving in cost of contact line effected by the use of this system. The cost of the part of the system between the power-house and the locomotives in the direct-current system is nearly equal to the cost of

both power-house and locomotives. On the other hand, the cost of the single-phase contact line, the only intervening element between the power-house and the locomotives, is less than one-half of the cost of the direct current transmission and contact system.

COMPARATIVE OPERATING COSTS.—Fig. 4 shows comparative operating costs for the three systems for the pusher service outlined in the preceding diagram of first costs. It should be noted that these costs do not include fixed charges. If fixed charges were included the difference in operating costs in favor of the single-phase system would be much more marked.

In connection with this diagram it should be noted that substation attendance is required for the direct-current system only. The reason for the three-phase and single-phase systems being so nearly on a par is that this case is an ideal one for the application of the three-phase system since it involves constant-speed operation under constant-load conditions. It is notable, however, that even under these conditions the single-phase system shows somewhat lower operating costs than the three-phase system.

The high operating cost with the direct-current system is seen to be due largely to the greater amount of power required for operation by this system on account of the large losses which occur between the power-house and the locomotive in this system.

Ductile Tungsten and Metal-Filament Electric Lamps.

It has been noted previously (Engineering News, April 21, p. 472) that a form of ductile tungsten has been developed, in the Research Laboratory of the General Electric Co., at Schenectady, N. Y., and that this can be drawn into wire for the filaments of incandescent electric lamps. The filaments of tungsten lamps previously marketed have been made only by difficult operations involving the sintering of minute particles of tungsten; hence the high cost of tungsten lamps has been due to these expensive processes rather than to the intrinsic value of the small amount of metal in the filament. The following extracts from recent papers before engineering societies, throw light on the latest developments in these high-efficiency lamps:

Metal Filament Lamps.*

By JOHN W. HOWELL, M. Am. Inst. E. E.†

Tungsten lamps were first placed on the market in this country about the beginning of 1907. They were sold in Europe in September, 1906. The development and production of these lamps since that time has been very rapid, and in 1909 about 10,000,000 lamps were sold in the United States.

Tungsten lamps when first introduced were rated at 1.25 watts per c.p. The announcement of this figure created an immediate interest in the lamp; lamp users anticipated a great reduction in their bills for current; current sellers feared this same reduction; lamp engineers and those with scientific interest in lamps were most keenly interested, for to them a lamp with normal life at 1.25 watts per c-p. meant a lamp over 200 times as good as the standard carbon lamp. [That is, such a tungsten lamp burned at 3.1 watts per c-p.—the operating point of the common carbon filament—would burn nearly 300 times as long as the standard carbon lamp.—Ed.] This figure represented to them the relative quality value of the new lamp when compared with the old standard carbon lamp.

Those who have used tungsten lamps with the object of reducing their bills have done so successfully, for if tungsten lamps are used to replace carbon lamps, candle for candle, a very material economy is effected and also much better lighting secured due to the much better color of the light and its much greater uniformity throughout the life of the lamp. Other users of the tungsten lamp have utilized the superior efficiency of the lamps to greatly increase the amount of light used while keeping the expense about what it was previously. Generally, however, a course between these two has been followed, the amount of light being materially increased and the cost of lighting also reduced; and experience has demonstrated that at current prices for electricity and lamps, the tungsten lamp will give much more light than will carbon lamps and at the same time reduce the cost of lighting.

The fears of current sellers that their income would be reduced by the introduction of tungsten lamps have not been realized, on the contrary, their income has been increased by the rapid extension of their business into new fields which were opened by the superiority of the new lamps, and by the availability of the larger sizes of lamps which, with carbon filaments, were not successful.

*Extracts from a paper before the American Institute of Electrical Engineers, New York York City, May 17.

†Engineer, Lamp Works, General Electric Co., Harrison, N. J.

The first tungsten lamps sold in this country were high candle-power, thick filament lamps. There were two reasons for this: the filaments were more easily made than were thinner filaments, and the field of high candle-power lamps had been very imperfectly filled by carbon lamps. These early lamps consumed 100 watts and gave 80 c-p.; they gave us what we did not have before, good incandescent lamps of high candle-power, and they extended the use of incandescent lamps into an unoccupied field. Since that time both higher and lower candle-power lamps have been developed and the adaptability of tungsten to the making of all sizes of filaments has been fully demonstrated. Lamps are now on the market using currents as low as 0.15 ampere and as high as 10 amperes in a single filament.

Tungsten has been a boon to the pocket battery flash light business, in which lamps are now used consuming only 0.4 of a watt. Lamps using 500 watts and giving 400 c-p. are used in large numbers and some 1,000-c-p. lamps have been made.

Lamps of the 220-volt class are also made. They require filaments twice the length of those required in 110-volt lamps, and they are therefore more liable to breakage, and are shorter lived at the same efficiency, than are the lamps of standard voltage.

Street series lamps taking from 3½ to 10 amps. and from 6 to 20 volts have short thick filaments and are very long lived and satisfactory lamps.

Tungsten is one of the heaviest metals known, having a specific gravity of about 20. Its melting point is over 3,000° C., according to Drs. Waidner and Burgess, which is higher than that of any other known metal. Its radiation characteristics are very favorable for its use as a light-giving source, for it possesses the quality called selective radiation, a relative term which implies that the proportion of its total radiations which are in the visible spectrum is greater than that of other substances which are considered normal.

The superior efficiency of tungsten lamps is due to these physical characteristics of the metal tungsten; namely, its ability to remain stable at a very high temperature, and its ability when at this high temperature to emit more than the normal proportion of its radiations in the visible spectrum.

Tungsten has other interesting characteristics; while its melting point is very high it oxidizes at a very low temperature—(about 300° C.). It also softens at a very low temperature, and filaments which are easily broken when cold can be bent permanently into any desired shape at a temperature below the oxidizing point. This characteristic is taken advantage of in making many filaments of special form, especially in making low-voltage lamps; many filaments of spiral or helical form are made by winding straight pieces of filament on hot mandrels. Similar forms of filaments when made of carbon must be made in the desired form before carbonization.

The change of resistance with voltage change in a tungsten filament is interesting, especially when compared with a carbon filament. The specific resistance cold of carbon is 800 times that of tungsten and at normal working temperature it is 33 times that of tungsten.

The low specific resistance of tungsten is a disadvantage in making high-voltage lamps, making it necessary to use very long thin filaments for these lamps. The length of filaments for 120-volt lamps ranges from 450 mm. for 20-watt lamps to 1,400 mm. for 500-watt lamps. The disposal of such long filaments within the proper sizes of bulbs has necessitated a great advance in the art and science of lamp making. This advance has been made, and lamps of standard voltage are now made ranging from 20 watts 16 c-p. to 500 watts 400 c-p., all of which are well designed and of good quality.

For low-voltage lamps this low specific resistance is an advantage, giving more desirable dimensions of filaments for such lamps. This advantage has caused a considerable increase in the use of low-voltage lamps for many purposes in connection with storage batteries, and has led to the introduction of residence lighting systems using 27 and 60-volt lamps, which are used with compensators or transformers on ordinary alternating-current circuits. These lamps have shorter and thicker filaments than lamps of standard voltage and the same candle-power. If filaments of the same diameter are used the filament will be one-quarter as long and give one-quarter the candle-power of the 100-volt lamps; thus, with the same filaments which are used in 20-watt, 100-volt lamps, lamps of 25 volts, 5 watts and giving 4 c.-p. are made. These low candle-power lamps are very desirable in residence lighting in places requiring only a little light, and in chandeliers and clusters in which ornamentation is required as well as illumination.

If we compare lamps of equal candle-power, the 25-volt lamps will have filaments 0.4 as long and 2.5 times the diameter of those in 100-volt lamps, and the 25-volt lamps will be less easily broken by rough handling and will give longer life at the same efficiency. This longer life is due to the greater diameter and shorter length of the filament, for a thicker filament is less affected by minute imperfections, and a shorter filament has proportionately less chance of containing such imperfections.

Many lamps are now used in automobile headlights. These lamps have short thick filaments, which are not broken by the vibrations or jars to which they are subjected, and are very convenient sources of light. The 10-c.p. lamps in good parabolic reflectors give a very satisfactory light. These require 12 watts each, and ordinary storage batteries are well adapted for their use.

The resistance characteristics affect the rates of change of the candle-powers, efficiencies and lives of these lamps with changes of voltage.

In a tungsten filament an increase in voltage is met and partly counteracted by an increase in resistance while, in a carbon filament, the resistance remains practically constant; consequently any increase in voltage produces less increase in watts, less increase in candle-power and less decrease in life in a tungsten filament than in a carbon filament. It will be observed that an increase of 3.7% in voltage will halve the life of a carbon lamp while it requires an increase of 5.2% to halve the life of a tungsten lamp. The cold resistance of a tungsten filament is only one-twelfth the resistance at normal operating temperature, consequently when first connected to the circuit the current is for an instant much greater than the normal current. This excessive current is of sufficient duration to cause an instantaneous rise in candle-power, which is higher than the normal candle-power; this effect has been called overshooting.

Tungsten filaments as generally made to-day consist of an agglomeration of fine particles of metallic tungsten. These particles are sintered or welded together by raising the filaments to a very high temperature in a reducing atmosphere. This sintering is made as complete as the limitation of our knowledge of the art permits, and while great improvements have been made in this matter the best filaments are still more fragile than are carbon filaments. This fragility has been the greatest obstacle met with in the introduction of tungsten lamps, and in the beginning, when filaments were much more fragile than they are to-day, and when people had not learned the degree of care necessary in handling them, and when prices were very high, this weakness prevented many people from using the lamps. Now, filaments are much stronger, people have learned to handle the lamps carefully and prices are lower, so that the sales of tungsten lamps are increasing rapidly. Flexible mountings for the interior structure of the lamps, which protect the filaments to a considerable degree, have been designed, and many lamps for railway car lighting and other special service are now being made, which have these flexible supports, to prevent breakage of the filaments in shipping and also in use.

The latest development which has been publicly announced is the drawn tungsten wire filament. This drawn wire has very great tensile strength, greater than steel, and can be drawn to any desired size. These filaments are very strong and are not injured by rough handling. In life and efficiency they are fully equal to pressed filaments.

Tungsten filaments when burning are quite soft and plastic and must be supported at points sufficiently near together to prevent the filaments sagging and touching each other or the glass. Spring supports are used in many lamps designed to prevent sagging and they do in fact keep the filaments nearly straight under all circumstances. These supports prevent the filaments being attracted over against the glass and being broken by static electricity which is a frequent cause of trouble with carbon lamps.

The variation of light from a filament due to the variation in current caused by the successive impulses of an alternating current depends upon the heat capacity of the filament, the heat radiating characteristic and the resistance characteristic. Tungsten has a specific gravity, about 10 times that of carbon and a specific heat one-fifth as great, so the heat capacity of a tungsten filament is about twice that of a carbon filament of the same dimensions. The heat radiating characteristic of tungsten is better than that of carbon because at a given temperature it radiates heat less rapidly than does carbon.

The resistance characteristic of tungsten is also more favorable than that of carbon for the retention of energy and heat as the current wave recedes. All these physical characteristics of tungsten are therefore better than those of carbon in respect to the retention of heat, and they all tend to make the flicker of tungsten lamps less than of carbon lamps of the same size filament.

The actual diameters of tungsten filaments, however, are much smaller than those of carbon filaments of the same candle-power lamps, and this more than offsets the advantages of the other characteristics, for the flickering of tungsten lamps is greater than that of carbon lamps of the same candle-power, while it is much less for lamps with the same size filaments.

The flicker of a 25-watt tungsten lamp on a 60-cycle circuit may be observed by standing with your back to the lamp and moving a pencil rapidly back and forth,

but I have been unable to observe this flicker by ordinary observation.

The flicker of a 40-watt tungsten lamp on a 60-cycle circuit is scarcely perceptible on a moving pencil.

Ductile Tungsten.*

By W. D. COOLIDGE.†

When work was first started on the problem of producing a ductile form of tungsten, the metal looked very uncompromising. It was so hard that it could not be filed without detriment to the file, and was, at ordinary temperatures, very brittle.

It was known from the start that, at the operating temperature of a tungsten lamp, the metal was soft; but this fact seemed unavailing, for there was no tool that could be used for working the metal at such temperatures, and materials from which such tools could be made were lacking.

To a man ignorant of our success, the problem would certainly look more hopeless to-day than it did then. For since that time millions of tungsten filaments have been produced from all available tungsten ores, by widely different methods, and by different groups of men. And each manufacturer has been fully alive to the fact that he must strive for the highest attainable purity. Yet all of the filaments made have been brittle. They are as elastic and flexible as spun glass, but, like the latter, are incapable of taking the slightest permanent set.

Not only was there nothing in the past history of tungsten to encourage us but, in the natural periodic system of the elements, the metal belonged to a family no member of which had been brought into a ductile state. The other members of the family are chromium, molybdenum, and uranium, elements which had always been characterized by hardness and brittleness. A study of the periodic system shows that, in a general way, elements of the same family do resemble one another in point of ductility, as well as in their other physical and chemical properties. For example, copper, silver, and gold are all in one family and are all very ductile. Little encouragement could be drawn from the achievement of Dr. Von Bolton with tantalum, because of the fact that this element is in a different family. And the two families differ markedly in both physical and chemical characteristics.

The only arguments on which we could base the hope that tungsten could be produced in a ductile state, were founded on the effect of mechanical working and of chemical purity on the ductility of some of the other unrelated elements. But even this hope seemed of doubtful fulfilment, owing to the apparently insuperable difficulties of mechanically working this particular material. Mechanical working increases the ductility of some metals. Cast zinc, for example, undergoes a marked increase in ductility when subjected to ordinary wire drawing processes. Some special steels, also, which, as cast, are coarsely crystalline, have to be handled very carefully until they have undergone a certain amount of mechanical reduction, while from this point on they are very ductile. Chemical purity also, is, in general, conducive to ductility and in some instances, slight amounts of impurity produce a marked effect. The analogy with iron is interesting for both tungsten and iron take up carbon, and may be greatly hardened thereby. And iron is extremely sensitive to traces of sulphur, phosphorus, and arsenic.

Our early experiments in mechanically working tungsten led to work on tungsten alloys, and on suspensions of tungsten powder in metals in which there was little or no alloying. One of the most interesting suspending media proved to be an alloy of cadmium, bismuth and mercury. This amalgam is very pliable. For our purpose it has several other important characteristics. Upon heating to about 140° C., it becomes soft and plastic, and from this point it retains its plasticity over a considerable temperature interval. While the amalgam is in this state, it is possible to incorporate with it considerable quantities of many foreign substances, such as tungsten, in powdered form. At room temperature, it is about as hard as lead, but, at a temperature of about 110° C., it can be readily pressed through a diamond die, and comes out as a strong pliable silvery wire. If this wire could be freed from everything but tungsten and still preserve its present strength and ductility, it would solve the tungsten-filament problem. But such is not the case. Upon heating it by the passage of current, in a non-oxidizing atmosphere, the mercury first distils out, then the cadmium and then the bismuth. Some shrinkage takes place as the foreign metals leave the filament, and the remainder is brought about by raising to white heat. Most of the ductility of the wire leaves with the mercury, and the remainder goes with the cadmium. This finished filament has been used in thousands of lamps, but these all lack ductility.

The above experience was duplicated when we tried copper as a binding agent for the tungsten, and again when nickel was used for this purpose. In each case there was a ductile stage in which the filament could be bent and otherwise manipulated, but not a trace of this ductility remained after the removal of the foreign element.

The above experiments gave us several new and valuable methods for producing tungsten filaments of the usual quality. But in so far as our ultimate goal, a ductile tungsten filament, was concerned, they were not promising. They were, however, in one respect, instructive, for in the case of all of the above and with many other foreign additions, we got a complete removal of the foreign elements, at least so far as our analytical tests showed, with the final high-temperature treatment of the filament. This seemed to indicate that we either did not need to worry about contamination from such elements, or else that brittleness was due to traces of impurity so minute as to escape detection by our analytical methods.

To return now to the mechanical working of pure tungsten. This work received a great impetus by our discovery that an ordinary, dense, well sintered, tungsten filament can easily be bent and put into various forms, and otherwise manipulated at temperatures well below redness, and even below the temperature at which appreciable oxidation takes place. This helped us in two ways. First, it reduced the temperature at which mechanical working operations could be carried on, and, second, it gave a means of recognizing which of the mechanical and chemical processes involved in our experiments were bringing us nearer to the goal. Anything which reduced the temperature at which the metal could be permanently bent was, clearly, helping us.

We found that steps tending to the elimination of the last traces of certain impurities did greatly improve the resulting product. While it may be true that certain impurities present in small amount are harmless or even helpful, we know that certain other impurities are detrimental. We also found that a certain micrographic structure in the tungsten rod with which we start, was conducive to mechanical working and to ductility in the resulting product. Once arrived at the point where mechanical working was easy and where there was a certain amount of ductility in the product, even when cold, the development became more rapid. It was aided by the construction of more refined apparatus, in the design of which care was taken to guard against the taking up of impurities during mechanical reduction processes, both from the atmosphere in which the work is carried on and from the surfaces of the tools.

Hand in hand with this improvement on the mechanical side has gone the work on greater chemical purity of the metal with which we start. One of the difficulties in purifying tungsten has been due to the fact, which has been pointed out by Smith and Exner and others, that tungstic acid is very prone to form difficultly separable complexes. Because of this tendency, especial care must be taken with regard to the purity of the reagents used, as otherwise recrystallization beyond a certain point does not result in corresponding purification. The knowledge obtained from our various lines of research now makes it possible for us to prepare tungsten which can be mechanically worked without more difficulty than would naturally attend the manipulation of very fine wire.

The product which we now have is perfectly pliable ductile wire, which has the strength of steel. It gives a lamp which is strong and whose filament retains its ductility throughout the life of the lamp. The following data on the drawn wire, obtained from measurements made in the laboratory by Dr. Colin G. Fink, may be of interest:

Dimeter (ins.)	Tensile strength (lbs. per sq. in.)	Specific gravity.
0.150	....	19.30
0.005	490,000	....
0.0028	530,000	....
0.0015	600,000	20.10

The electrical resistivity at 25° C., expressed in microhms per centimeter cube, is, for the hard-drawn wire 6.2, and for the same annealed, 5.0. The temperature coefficient of electrical resistivity between 0° and 170° C. is 0.0051 per degree C.

The above values, with the possible exception of the temperature coefficient, are of course somewhat dependent on the early history of the wire from which they were determined.

The work which has been outlined above is the result of the close cooperation of about 20 trained research chemists, with a large body of assistants, in the research laboratory. These men were of course given, from the factory organization, all of the mechanical and electrical assistance they could use, and were assisted in no small measure by the staff of the incandescent lamp factory.

[Dr. C. G. Fink, of Schenectady, in a paper on "Ductile Tungsten," presented to the American Electrochemical Society at Pittsburg, May 4, stated that another metal of this group, molybdenum, had been secured in ductile form. Its tensile strengths are 260,000 and 310,000 lbs. for wires of 0.005 and 0.0015-in. diameters, respectively. The specific gravity is between 10.1 and 10.32, depending on the amount of working. The electrical resistivities were given as 5.6 and 4.8 for hard drawn and annealed wires. Its temperature-resistance coefficient is stated to be 0.005, or about that of copper.—Ed.]

*Extract from a paper before the American Institute of Electrical Engineers, New York City, May 17.

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A New Form of Tungsten Lamp.*

By CHAS. F. SCOTT.†

The "wire type" is the name of a new form of tungsten lamp developed by the engineers of the Westinghouse Lamp Co. which possess several characteristics which mark an advance in the metal-filament lamp, and which commend themselves to those who use these lamps.

Why is the ordinary tungsten filament lamp so fragile? It is so on account of both the material of which the filament is made and the way in which it is held. The tungsten filament is mechanically quite similar to glass. If one wished to ship a glass rod, he would either bind it to a stick, and thus support it throughout its entire length, or he would pack it in soft material. The worst way to hold it would be to fasten it rigidly to heavy supports at its ends. And yet the fragile tungsten filament is held rigidly at its ends. Furthermore, in the ordinary lamp the total filament consists of four or five hair-pin shaped parts, each rigidly fastened to stiff wires at its ends, making a total of eight or ten points of rigid support.

The support is made absolutely rigid usually by electrically welding or fusing the supporting wire around the tiny filament. Mechanically this is the ideal way not to hold the fragile tungsten thread. The logical result follows; one of the best known features of the lamp is its fragility, and the mechanical break almost invariably occurs near the fused support. Now, the reason for this unfortunate construction is that tungsten filaments are ordinarily made in short lengths in hair-pin shape. It has not been practicable by usual methods to make and mount single filaments having a length of the 30 ins., more or less, which is necessary for a 110-volt lamp. Consequently, it has been common practice to connect in series a number of individual short filaments by fusing their ends to stiff supporting wires. Hence, the mechanical monstrosity of rigidly supporting a delicate and fragile filament results from the necessity of using many individual filaments, adapted in length to the size of the lamp bulb.

The ideal way to overcome these difficulties is to employ a single filament, and to mount it without fastening it rigidly to its supports. This requires three things; first, a single or continuous filament; second, it must be wound back and forth and loosely supported at numerous points, giving a final form appropriate to the ordinary lamp bulb; and third, the ends of the filament must make a suitable electrical contact with the leading-in wires, without the fatal rigidity. These elements are realized in the new form of lamp.

The thing which makes the new lamp possible is the development of a new method of manufacturing the filament by which it is produced in long lengths. It is then ready to be wound, like wire from a coil. A few turns near each end of the filament are wound in the form of a spiral spring around the respective leading-in wires, and to further insure contact the ends are fused. The fused and rigid connection between the leading-in wire and the end of the filament is thus protected from the straight part of the filament by several turns of the filament around the leading-in wire, these turns acting as a sort of spring, so that a slight bending of the filament resulting from a blow or vibration does not act directly upon the fused joint, as it would if a straight part of the filament came directly from the fused joint, as in the ordinary construction. Furthermore, any carelessness in the act of fusing which may damage or weaken the filament is of minor consequence in the wire-type lamp; whereas it may seriously lessen the strength of the filament in the common form of lamps. Hence, the three elements, a single long filament, intermediate supports which hold the filament loosely and a terminal which is mechanically and electrically satisfactory, are all secured in the new wire-type lamp.

Not only does the single long filament permit improved mechanical construction of the lamp, but it insures a quality and uniformity in the filament which are essential to a good lamp. It is well known that when either carbon or tungsten lamps are to be operated in series, special precautions are necessary in order to secure lamps that are similar. If they are unlike, then the lamp which has a normal current less than the others burns too brightly, as all of the lamps are forced to receive the same current, and hence its life is shortened. In the ordinary type of tungsten lamp in which several independent filaments are connected in series, the condition is very similar to the operation of independent lamps in series. If, therefore, the filaments

*From a paper read at the annual convention of the National Electric Light Association, St. Louis, May 24.

†Consulting Engineer, Westinghouse Electric & Manufacturing Co., Pittsburg.

are not identical, the smaller or weaker filament will have too great a current forced through it, thereby shortening its life. The condition is more unfortunate than when independent lamps are burned in series, for the reason, that when there are independent lamps, the burning out of one does not affect the others. On the other hand, when one filament in a lamp burns out, the other filaments, although they may be in first-class condition are useless.

The practical bearing of the importance of small differences in filaments will be appreciated when the conditions in the manufacture of individual extruded filaments are mentioned. Variations due to the use of different dies, or the same die at different periods in its service, and variations in the different stages of the process of treating or forming the filament are liable to cause minor differences. In general, therefore, a lamp in which the filaments are individually and independently produced is liable to variations and differences which can be avoided only by very careful and accurate selection.

The accurate sorting and classification of tungsten filaments which are to be used in the same lamp is ordinarily accomplished by electrical measurement. This is not only a convenient method, but it is essential on account of the nature and size of the filament. Tungsten filaments usually have a slightly roughened surface as viewed under the microscope so that it is impracticable to secure a definite, exact measurement of the effective diameter. Even were the filament perfectly cylindrical, the mechanical measurement would involve infinitesimal quantities. For example, the filament of the ordinary 25-watt lamp is approximately 0.001-in. in diameter. A difference in diameter between two otherwise similar filaments of as much as 1% would be entirely inadmissible. As 1% is 0.00001 of an inch, it is obviously fortunate that no such measurements have to be made, but that electricity itself affords a ready and convenient method of determining the uniformity by electrical measurement.

It is evident that a process in which a yard or more of filament is made in one piece is not liable to the differences which are possible and probable when a lamp contains several filaments which have been made at different times and under the necessarily different conditions which are incident to commercial manufacture. Owing to the uniformity of treatment which the single long filament receives and the resulting uniformity in diameter and in character, the selection of filaments by resistance measurement which is absolutely essential in the ordinary manufacture of lamps with separate filaments is practically eliminated.

The mechanical excellence of the new lamp is attested by the results of some simple experiments in which lamps of the wire type have been put under identical tests with lamps of the ordinary type having several filaments fused to the supporting wires.

Lamps of the fused type from different makers showed a substantial equality among themselves under similar tests. In one test, lamps were mounted in wall sockets which were screwed to an ordinary poplar board ½-in. thick and 6 ins. wide, which was held on supports about 4 ft. apart. Sockets were attached to this board as shown in Fig. 5, and were supplied with lamps of the two types, respectively. In the first test, the lamps were in the ordinary pendant position under the middle of the board. An iron weight, sliding freely on a guiding rod which was fastened to the board on which the lamps were mounted, was then dropped upon the board, thus representing, in a general way, the condition in which a lamp is attached to a ceiling where it is subjected to jar from overhead. Each time the weight of 1.75 lbs. was dropped, the distance was increased by 2 ins. Ten tests each were made on 60-watt, 40-watt and 25-watt sizes. In each test two lamps were used, one of each type in the two similar sockets, each type of lamp being placed alternately in each socket to insure identical conditions of test. There was no current through the lamps when the weight was dropped, but current could be applied to determine whether the filament was broken. The distance through which the weight dropped when each lamp broke was noted and the average was taken of the five lesser values and also of the five larger values. The results show in general that the breakage of the wire type requires that the weight be dropped from about four or more times the height that causes destruction of the fused type of lamp.

A second and similar dropping test was made with the lamps in a horizontal position instead of a vertical position. A weight of 1.1 lbs. was used. From this it appears that the average wire type lamp can withstand the dropping of the weight from about six times the height that is fatal to the fused type.

An additional mechanical test of another kind was made by rolling the lamps off a board onto the top of a table. The height of the fall was gradually increased. In order that the lamp might strike on its side, a light wooden guide rod was attached to a thin copper socket so that the lamp would maintain its axis approximately horizontal at all times. The height from which the lamp was rolled was increased between tests. The average height from which the lamps were dropped when the filament broke shows that the wire-type can withstand approximately twice the fall that the fused type can withstand. The mechanical tests in the aggregate show that the wire-wound type of lamp is much less liable to injury than the fused-type lamp when subjected to blows which are of a kind similar to those which may be expected in service.

The wire-type tungsten filament is made in long lengths, the present equipment making several miles a day. The wire-type of lamp has been under experimental development for a year and a half, and some of the lamps were in service early in January, 1909.

An Efficient Reflector for Street Lamps.

Heretofore, the design of reflectors for street-lamps has been made much as for interior fixtures. While one fundamental difference in the services of the two classes of fixtures has been recognized—the desirability of reflecting all light from above a horizontal plane through the light source—the difference has not been effectively embodied in familiar outdoor fixtures. Dr. Clayton H. Sharp, M. Am. Inst. E. E., of the Electrical Testing Laboratories, New York City, has recently patented a design which directs all the rays above the horizontal plane to such a part of the street as it may be deemed advisable. In most cases it is desirable to have comparatively little light reflected crosswise of the road while most such should be sent lengthwise in a wide non-diverging beam or in a smaller moderately divergent beam. This is not the condition in the case of unfurnished lamps or of lamps having generally symmetrical reflectors.

The design of Dr. Sharp makes use of the properties of a parabolic reflector having a source of light at the focus. As a single semi-paraboloid would direct light only in one direction, two such surfaces are joined near their

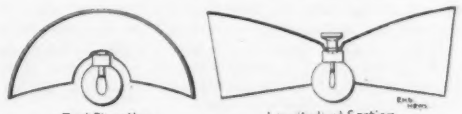

Fig. 1. A Double Parabolic Reflector for Street Lamps.
(Designed by Dr. C. H. Sharp, Electrical Testing Laboratories, New York City.)

focal planes as shown in Fig. 1. The axes of the paraboloids are inclined downward slightly and the lamp is suspended so that the foci and filament center approximately coincide. If the light source were a point each half reflector would throw a straight beam illuminating only a small area some distance from the lamp but, with commercial extended sources of light the beam becomes divergent and covers all of the street area on which it is desired to increase the illumination.

More than two paraboloids may be combined in a single reflector where it is desired to redistribute light in more than two directions.

This design of reflector has been developed in commercial form, with the assistance of Mr. S. G. Rhodes, Engineer of the Street Lighting Department of the New York Edison Co. A typical form for incandescent lamps is seen in Fig. 2. To this reflector the trade name "Equilux" has been given.

The first reflectors were made from spun zinc and were burnished on the inside. Fig. 3 shows the results of tests with two of these early reflectors used with a 50-c. p. metallized carbon lamp, on a poorly lighted street having fixtures 300 ft. apart.

Fig. 2. Commercial Form of Sharp "Equilux" Reflector.

The present commercial forms are slightly less efficient, as a white enamel has been applied to the inside in preference to burnishing the metal. The illumination underneath each lamp is increased by diffuse reflection from the enamel. Even with these forms the increase of illumination on the desired areas (midway between lamps some 300 ft. apart) is some 50%. In certain highways where the lamps could be sufficiently elevated, it is proposed to return to the burnished metal reflecting surfaces to secure the more effective and efficient action where the glare will not be troublesome. This glare, at the worst, is not to be compared with that from an open arc.

The appearance of these reflectors, as seen from Fig. 2, is odd at first but there seems no reason why they may not be made graceful in commercial adaptations. At least their shape indicates their service—a fundamental artistic requirement of such designs.

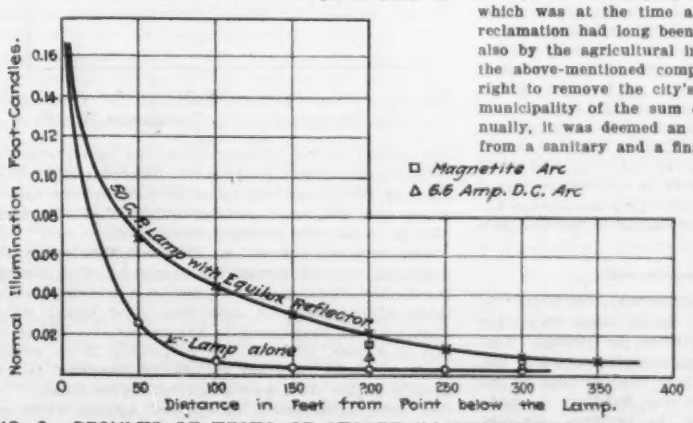

FIG. 3. RESULTS OF TESTS OF STREET ILLUMINATIONS, WITH AND WITHOUT SHARP PARABOLIC REFLECTORS.
(From a paper before the Illuminating Engineering Society.)

Disposal of Garbage and Other Municipal Refuse, Marseilles, France.*

In the following report Consul-General A. Gaulin describes the experiments that have been carried on in the French city of Marseilles in the disposition of garbage, and the system that has been worked out:

For a great number of years the street sweepings and general refuse of the city of Marseilles were dumped at certain points in the suburban districts, and placed at the disposal of farmers in the neighborhood. During 1883, after two consecutive epidemics of cholera, a special service for discharging the city's garbage into the sea was organized. But this system was found too costly and unsatisfactory from a hygienic standpoint, as in stormy weather the sea frequently brought back considerable quantities of detritus which had been left too near the shore.

Another solution of the problem was therefore adopted in 1887, when the municipality decided to accept the offers of a private company, which had undertaken to fertilize a vast territory known as the Plaine de Crau, about 70 kilometers (43.49 miles) from Marseilles, and proposed to use the city's garbage for this purpose. The pebbly plains of the Crau cover an area almost equal to 45,000 hectares (111,196 acres), the greater part of which was at the time absolutely barren, although its reclamation had long been advocated by economists, and also by the agricultural interests of the district. When the above-mentioned company applied for the exclusive right to remove the city's refuse, upon payment by the municipality of the sum of 54,000 francs ($10,422) annually, it was deemed an advantageous proposition, both from a sanitary and a financial standpoint, as the city's expenditure on this score amounted every year to at least 78,000 francs ($15,054). The probable increase in the agricultural wealth of the Marseilles region which might result from the execution of the proposed contract was also taken into account, and a franchise was accordingly granted upon the terms already stated.

AUTOMATIC METHOD OF HANDLING REFUSE.—It

*From U. S. Monthly Consular and Trade Reports.

was agreed that the street-cleaning department would deliver every day of the year at the dispatch stations of the company all the sweepings, detritus, and refuse collected in the city and its suburbs, and that the company would remove these materials by rail within the next 12 hours to the Crau plains, excepting, however, such quantities as might be required by the suburban farming communities. Two dispatch stations were established, both being located at convenient points in the city limits, and connected with the railway. Special platforms have also been erected, from which the street cleaning department's tip carts may easily unload their contents into the cars below. Fifteen cars may be loaded at the same time. The type of car provided for this purpose is that commonly used for carrying coal. There are two deliveries per day, and the total daily load averages 276 metric tons.

The cars usually leave the dispatch stations at sundown each day and arrive at their destination (Bausseuc in the Crau) at sunrise the following day. As it takes 24 hours before a mass of garbage will begin to ferment its transportation in open cars within a few hours after it has been collected has been found to offer no inconvenience from a sanitary point of view. The contents of the cars are dumped along a special track connecting the company's plant (which is several miles distant from any habitation) with the principal railway line. Movable tracks are used for the transportation of manure wherever needed on the plains, this operation being facilitated by the fact that the land is perfectly level and without growth of any kind. Immediately after unloading the raw materials are raked and such articles as bottles, paper, scrap iron, and the like sorted out by hand and utilized in various ways. The stones serve chiefly as ballast for the railway tracks and for the macadamizing of roads.

UTILIZATION AS FERTILIZER.—The residue is shoveled into the hopper of a crushing machine, where it is compressed. It may then be sold as green garbage, "gadoues vertes," or allowed to ferment for several months, when it presents the appearance of a black earthy mass designated as "gadoues noires." The purchasers of "gadoues vertes" never use them in their raw state, but only after fermentation.

This fertilizer has been found most efficacious for vegetable gardening and vineyard culture. It is preferred for these purposes to farm and stable manure and to chemical products. Large quantities are shipped from the Bausseuc plant to the truck farmers and wine growers in this district. Until now, however, the greater portion has been consumed on the Crau plains. Over 5,000 hectares (12,355 acres) have thus been won over to profitable culture, and 12,000 hectares (29,652 acres) in that vicinity supplied with fertilizing elements.

Analyses of the product in question have shown as a rule the following composition: Azote (nitrogen) 0.68%; phosphoric acid, 0.94%; potassium, 0.58%; calcium, 1.32%. As the soil of the Crau is especially lacking in azote and phosphoric acid, this fertilizer has proved extremely well adapted to its needs. From 20 to 25 tons are required per hectare (2.47 acres), and leading authorities state that it should alternate at least every three years with other organic and mineral fertilizers.

PRICES CHARGED—MODIFIED SYSTEM.—It is sold in carload lots and shipped either in bulk or in bags, at prices varying from 0.5 franc (9.65 cts.) to 3 francs (57.9 cts.) per ton, according to the seasons and to the agricultural situation. The truck farmers in the immediate vicinity of Marseilles have the right to buy "gadoues vertes" at the dispatch stations in Marseilles, but in most cases deliveries are made to them in the company's carts. They take only a very small share of the total production.

House sewage is not utilized as a fertilizing medium in Marseilles, but is discharged into the sea at a distance of 10 kilometers (6.21 miles) from the city. A certain quantity of fecal matter is still mixed with the general refuse, but owing to the gradual extension of the sewer system this is constantly and rapidly decreasing.

The company mentioned recently transferred its interests to a new concern, to which the city granted a franchise expiring in 1934, with the right to erect within the city limits two plants where all the detritus collected in Marseilles may be mechanically treated, and all unmarketable articles found therein shall be incinerated. This system is not yet in operation, and there is no definite information available on the subject. Under the present arrangements the city pays an annual indemnity of 44,000 francs ($8,492) instead of 54,000 francs ($10,422) as heretofore.

A HOUSE FOR THE GEOLOGICAL SURVEY in Washington, D. C., is included among those authorized by the public-buildings bill recently put through Congress. No appropriations are involved in this bill, but the sum of $96,000, left over from the purchase of the site for the Survey's proposed new building, is made available for immediate use on the building. On this basis, negotiations for plans and specifications for the new building will be opened at once.

A Railway Signal with Illuminated Background.

One of the difficulties in railway signaling is to make the signal (and its position) conspicuous under all conditions of location, and in certain exceptional cases a wooden panel has been placed behind an ordinary semaphore signal to form an artificial background. Illuminated semaphores have been used experimentally, giving a "position" indication both by day and night, but none of these have come into regular use. In some of these signals the light was projected into a hollow semaphore arm having a glass face, while in others the light was projected upon a corrugated glass strip attached to the arm. The Koyl signal, in use at one time on the Lehigh Valley Ry., was of the latter type. An illuminated indicator to distinguish distant signals at night is in use on some English railways; this is of the former type and was illustrated in our issue of July 26, 1906. For the meeting of the Railway Signal Association in New York on June 14, a paper was prepared by Mr. J. H. Wisner, Jr.,* describing a system in which each signal has a background consisting of a panel of horizontal steel strips; this is illuminated at night by a lamp on the back of the post, so that the semaphore arm and its position are clearly visible both by day and night. From this paper we take the following extracts:

The signal consists of a semaphore pole mounted before a white screen or background placed several feet behind it. A lantern is attached to the back of the pole and the light is showered on the background in a greatly intensified form through the use of a reflector of special design within the lantern. The screen being white, a bright background is secured at night, against which the post and blade are seen in a striking silhouette.

Experiments have shown that it is not necessary to have a background of exceeding whiteness nor an illumination of high power in order to make the semaphore visible at a great distance. A small flame produces in effect a moonlight or phosphorescent appearance upon the screen against which the signal indication is plainly visible at several thousand feet.

Many experiments were performed to convince ourselves on this point. In front of the screen two curtains were arranged in such manner that one at a time could be lowered. Curtain No. 1 was of a pearl gray, or such a color as a white screen might be expected to take after being exposed to the smoky atmosphere in the vicinity of yards and terminals. Curtain No. 2 was of a dark slate color, representing a screen very badly soiled.

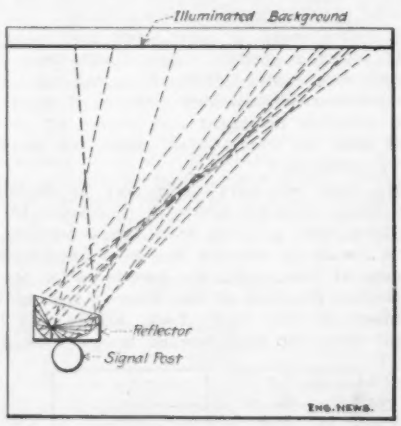

Fig. 1. Arrangement of Reflector for Illuminating the Background of a Semaphore Signal.

Our present method of constructing the background (described later) largely obviates the difficulties of discoloration by smoke, and settlement of dust, but the experiments with the tinted curtains proved slight discolorations to be not very seriously detrimental.

With Curtain No. 1, and no additional illumination, the indication was not perceptibly impaired. With Curtain No. 2, the indication could be seen at a considerable distance with astonishing definition. One signal which stood near the roundhouse in Tyrone, Pa., for the better part of a year, where it was continually in an atmosphere of smoke, was not sufficiently discolored to noticeably impair the aspect either by day or night.

In order to secure a background against which all parts of the signal, in whatever position, will appear with equal distinctness, it is necessary that the screen be uniformly illuminated throughout its whole area. This is secured by virtue of a reflector (within the lantern) composed of small panels placed at such an angle with each other and with the light, that a particular region of the screen is illuminated by the reflected light from each panel. Fig. 1 shows a plan of the reflector, the screen, and the rays of light.

The screen is a strong steel frame, containing a surface composed of 3-in. horizontal strips, the surface of each being placed at an angle of about 20° with the vertical; their position is not unlike the slats of a Venetian blind, with the strips facing downward toward the

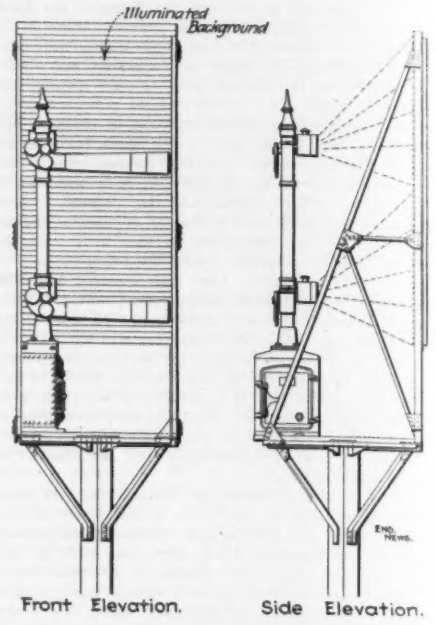

Fig. 2. Block Signal with Illuminated Background.
(The World Signal Co., Philipsburg, Pa., Maker.)

front. (Fig. 2.) The benefit of this design is the reduced pressure exerted by the wind. A secondary advantage is that the surface, by facing downward, reflects the light toward the track with greater intensity than in any other direction. Moreover, any settlement of dust or smoke from the atmosphere must lodge mainly on the back of the strips.

An observation of the signal was made at Tyrone, Pa., in a driving fog and drizzle, from the rear of a train starting from the signal. As the distance became greater the lights were lost to sight, being obscured by the driving storm. The green, red and white lights disappeared in the order named and when the white could no longer be seen, the position of the signal arm could still be observed.

It is the opinion of the writer, and one which has been corroborated by statements from a large number of locomotive enginemen, that the majority of enginemen endeavor to discern the position of the signal arm when passing the semaphore at night, far greater reliance being placed upon this indication than upon that by lights even among men who believe their vision to be entirely normal. Men who could not tell one light from another have been found at the throttle of locomotives. These men (together with others afflicted in less degree) have been seeing the semaphore arm. It may have been necessary to slow the train down when the night was dark or to take risks when this was impossible.

With the new signal, the blade can be seen, not only while passing it, but at many thousand feet down the track. An engineman need have no special faculty to read it. No fatigue or disorder could make it appear other than it is.

*The World Signal Co., Philipsburg, Pa.

MUCH RAILWAY CONSTRUCTION IN TEXAS was achieved during the past year (ending June 30, 1910). Nearly 800 miles of new main track and branch lines were built, according to the official reports made to the State Railroad Commission. Actual figures so far received mount up to 735 miles, and it is estimated that the figures yet outstanding will bring the total to about 800. This brings Texas' total of railway line to about 14,000 miles, not counting some 1,500 miles of logging roads and 3,200 miles of sidings and yard tracks. It is also worth note that grading work is in progress on new lines and extensions amounting to over 1,200 miles. Much of this work will be completed by July, 1911, it is expected. Longest of the new lines is the Santa Fe cut-off, Coleman to Texico, 310 miles.

Convention of the American Institute of Electrical Engineers.

The annual convention of the American Institute of Electrical Engineers opened at the Hotel Waumbek, Jefferson, N. H., on June 28. By the close of the last session on July 1 there were 175 members and guests registered. The entertainment features were well planned and evidently well enjoyed though not to the detriment of the more serious work of the meetings. At the opening session four solid hours, with almost full attendance, were devoted to the presidential address and to four papers secured by the Electric Lighting Committee. (All papers were printed in advance, and read by abstract only, giving more time for discussion.)

President L. B. Stillwell took as the theme of his address "The Conservation of Water-Powers." The paper is printed at length elsewhere in this issue. On motion of Dr. C. P. Steinmetz, of Schenectady, the Directors of the Institute were requested to bring the address to the attention of proper government officials as expressing the sentiment of the Institute membership and as seeking appropriate legislation.

Electric Lighting.

The papers under this classification were rather on allied subjects. Perhaps the one most closely adhering to lighting was "Carbon Filament Lamps as Photometric Standards," by Messrs. E. B. Rosa and G. W. Middlekauff, of the U. S. Bureau of Standards, Washington, D. C. The author describes the arrangement of photometric apparatus devised to record a maximum number of readings with a minimum use of the "standard" lamps and reported the results of long studies into the "seasoning" of incandescent carbon filaments and the accuracy of results. They reported finding (1) that with a good lamp the candle power was practically constant for constant energy input, rather than for constant current or voltage and (2) that candle power could be measured, by trained observers and refined apparatus, to 0.2% error on any one lamp, to 0.1% average error on 6 lamps measured at once, to a less error still if the averages of four men were taken.

From such showing, the authors contended that proper and seasoned incandescent lamps were desirable primary standards for even a group of international standardizing laboratories.

Dr. C. P. Steinmetz, in objecting to the broad application of this last statement, called attention to the tendency of all primary standards, not reproducible from specifications, to "drift" and contended that it would ultimately be recognized that a proper standard would embody the combination of measured radiations of given energy and frequency (spectrum lines) to eliminate drift.

In "Headlight Tests" by Messrs. C. F. Harding and A. N. Topping of Purdue University, Lafayette, Ind., the work of a special committee for the Indiana Railroad Commission was sketched. The tests were of two kinds—road and laboratory. The first of these have already been described by Prof. C. H. Benjamin (see Eng. News, April 21, 1910, p. 476). The result of such observations has been to bring out two great disadvantages—(1) the "phantom signals" caused by reflections from glass roundels and (2) the difficulty of observing signals or obstructions in the glare from a strong headlight of a locomotive approaching on a parallel track.

The laboratory tests reported were undertaken to obtain photometric and spectrophotometric data useful in the analysis of effects of such high-power headlights.

In the discussion of this paper it developed that the Railroad Commission believed that by cutting down the nominal rating of "2,000 c.p.," first demanded by trainmen, to "1,500 c.p.," a headlight more intense than the oil type would be secured but not one so intense as to cause phantom signals or undue glare. This specification was described as meaningless as it did not define how or where the candle power was to be measured. Half the headlights in Indiana must be equipped with the new headlights by Jan. 1, 1911, and half by July following.

"The Modern Oil Switch With Special Reference to Systems of Moderate Voltage and Large Ampere Capacity" brought out a vigorous discussion. The contention of the author, Mr. A. R. Cheyney, Superintendent of Operation, Philadelphia Electric Co., was that while oil switches with overload releases, as now applied to circuits wherein heavy power was concentrated, would almost invariably open the circuit in case of short circuits, etc., some oil would be ejected and carbonized and the contacts would be burned away so that the switches would require careful overhauling after each such operation. Many operating data, from the author's experience, were included in support of his contention.

In the discussion, the operating men generally agreed with the author while most of the designers and manufacturers disagreed—more or less. For instance, it was claimed that the oil switch itself did not need so much improvement as did its operating conditions. The power systems needed subdivision, it was claimed, so that no single switch had to open under unlimited power. The manufacturer's tests were cited as showing that such apparatus would open many hundred times, at rated loads, without injury but that they could not operate under overloads without injury in proportion to the excess momentary power.

High-Tension Transmission.

Three of the papers presented under the auspices of the High-Tension Transmission Committee occupied all of the time allotted to such subjects and a part of a supplementary long session which seriously interfered with the attendance at the golf tournaments and baseball game.

The first of these papers, "Disruptive Strength With Transient Voltages," by Mr. S. L. R. Hayden and Dr. C. P. Steinmetz, described the methods and results of a series of tests with supposedly single impulses of voltage with limited energy. These were undertaken to throw light on the experience that voltage disturbances of limited energy have not shown the disruptive effects expected from their voltage and that there is a small time lag between application of voltage and consequent breakdown of insulation. As a result the authors came to the conclusions (1) that a disruptive discharge requires a definite minimum amount of energy back of it besides a sufficiently high voltage; (2) that the disruptive energy was supplied to the insulation during the slight "time-lag"; (3) that the disruptive energy of oil was 30 times that of air and that probably this factor was larger for solid dielectrics; (4) that the time lag was greater with greater energy required for disruption.

The second of this series of papers was "The Electric Strength of Air" by Dr. J. B. Whitehead, Johns Hopkins University, Baltimore, Md. The apparatus, methods, and results were here given of a series of studies into the potentials at which air first fails as an insulator (conduction by ionization phenomena.) By enclosing uniform and polished specimens of wire concentrically within a metal tube and by controlling the condition of the air made to flow through, the potentials between wire and tube could be studied up to breakdown of air molecules into charged particles, or ions, which were detected by gold-leaf electroscopes. The author concluded, from his experiments, that temperature and pressure caused the greatest variations in the strength of the air, that water vapor had no influence, that breakdown (ionization) was independent of the material of electrodes but was influenced by roughness of electrodes.

In "The Dielectric Strength of Oil," Mr. H. W. Tobey, of Pittsfield, Mass., reviewed the knowledge experimentally obtained of the physical properties of insulating oils for use in transformers, switches, etc. Perhaps the most striking thing shown was the effect of moisture; 0.03% reduced the dielectric strength 25% and 0.1% moisture reduced it by 50%. The former figure is equivalent to five or six drops of water per quart. A second phenomenon interesting to those having transformers subject to low temperatures was the great increase (75%) in voltage needed to breakdown oil after congealing (at — 10° C ±).

These three papers were discussed simultaneously and the most of the discussion centered on the second, "The Electric Strength of Air." Dr. Whitehead's conclusion that moisture had no effect on the breakdown potential for air finally remained generally contradictory of deductions from tests by Mr. Ralph D. Mershon, presented before the Institute Convention in June, 1908. (Eng. News, July, 9, 1908, p. 44.)

The program of the High-Tension Committee included four other papers of considerable length and all capable of producing discussion hard to curtail. It was remarked, indeed, that this committee had material for an entire convention.

In one of these papers, "Vector Power," Dr. A. E. Kennelly, of Cambridge, Mass., called attention to the confused mathematical conventions developed in the algebra and geometry of elementary alternating-current texts. The paper also presented some rather complicated methods of studying the power in alternating-current circuits.

In another paper, Prof. Adolph Shane, of Ames, Iowa, described two methods of testing voltage regulation of transformers. These were intended as commercial tests for which greater accuracy was claimed than present accepted methods assure.

The two remaining papers of the series were "Observation of Harmonics in Current and in Voltage Wave Shapes of Transformers," by J. J. Frank of Pittsfield, Mass., and "Parallel Operation of Three-Phase Generators With Neutrals Interconnected," by Mr. G. I. Rhodes, Interborough Rapid Transit Co., New York City. Both of these papers were read at an Institute meeting in San Francisco in May and were re-presented for further discussion. Unfortunately opportunity to discuss was denied the enthusiastic members although several hours of the only available session remained before breakfast.

Telegraph and Telephone Engineering.

This committee modestly presented only two papers. The first of these "Notes On The History and Practice of American Telephone Engineering," by Mr. Wm. Maver, Jr., Consulting Engineer, New York City, contained a reminiscent history of the rise and decline of many automatic systems and also a review of present practice and tendencies.

The second paper was "Telephone Engineering Around the Golden Gate." In this paper Prof. A. B. Smith, Purdue University, Lafayette, Ind., first outlined the requirements which a system should have for a large cosmopolitan city with important suburban districts. After this an automatic system was described, as installed in San Francisco, Oakland and neighboring districts, particular attention being paid to the arrangement of circuits for suburban and long distance calls where operators replaced, in part, the pure mechanisms of the local automatic system—as this service was held to consist in getting two persons into communication rather than two telephones.

Industrial Power.

The committee on this subject was even more modest than the preceding committee. The only paper presented was "Interaction of Fly Wheels and Motors When Driving Roll Trains," by Mr. F. G. Gasche, of the U. S. Steel Corporation. The presentation of the paper was a mere formality as it was wholly mathematical, but it was hailed by many present as giving an easy logical method of studying motor requirements in the fly-wheel local storage of power generally, whereas before they attacked the problem laboriously.

Electric Traction.

One session was given up to the Railway Committee, and under its direction four papers were read. In one of these, "Power Economy in Electric Railway Operation—Coasting Tests on the Manhattan Railway, New York," Mr. H. S. Putnam, of New York City, described tests on the elevated lines of New York in which a special clock was used to record the amount of coasting

employed in the operation of trains. The balance wheel on this recording timepiece was normally braked but was released by an electromagnet during coasting—that is with no current in the motors and the brakes not set. It was found that by training the motormen to secure a higher percentage of braking and by using these clocks to record the men's performance, the average percentage of total run that was coasted could be raised from 12% to 37.5%. This was accompanied with a saving of 24% in power required for traction.

Mr. C. J. Hopkins, of Philadelphia, Pa., also discussed the benefits of increased coasting in the paper "Economy of Car Operation." His argument was that the use of "anti-friction" (or ball) bearings allowed a quicker acceleration, smaller maximum speed and longer coasting period for a given schedule and thereby materially reduced the energy consumption over the best run of a car with ordinary brass bearings. Tests made on the Atlantic City and Shore R. R., (suburban section, 15.2 miles), were cited as showing a decreased power requirement of some 13%. Besides this there was considerable saving in brake maintenance.

The paper, "A Method of Determining the Adequacy of an Electric Railway System," by Mr. R. W. Harris, Madison, Wis., described the systematic study, made under his direction, of the Milwaukee street-railway system by the Wisconsin Railroad Commission. The paper outlines the observations made on car headway delays, traffic density, celerity of passengers, peak loads, destinations, transfers, possible re-routings, etc., etc., which form the basis of judging of present adequacy, growth and inherent limitations of service. The material of this paper is also found in a report of the Wisconsin Railroad Commission (Eng. News, March 24, 1910).

In "Electric Locomotive Design" Messrs. N. W. Storer and G. M. Eaton, of Pittsburg, sketched in broad outline the many conflicting requirements of the railway general superintendents, superintendents of motive power, engineers of maintenance of way, presidents, etc., to show that every completed locomotive was a compromise design and not an ideal machine from every point of view. The paper also gave a brief analytical review of present practice, here and abroad, as to transmission, framing, wheel arrangement, equilization, center of gravity, location, etc.

The most important discussion of all these papers centered on a few features of design mentioned in this last one. For instance, it was emphatically maintained that the high center of gravity now demanded by steam-railroad men was of far less importance in effect on track maintenance and safety than a small width between spring supports of dead mass and grouping heavy parts about the longitudinal center. The need was also explained for a combined passenger and freight type for heavy-grade, nonstop service.

Miscellaneous Matters.

There was but one paper presented as papers have been generally in the past—not under the auspices of a technical committee. This was "Recent Progress in Exact Alternating-Current Measurements," by Messrs. C. H. Sharp and W. W. Crawford, New York Testing Laboratories, New York City. They described the construction of several pieces of laboratory apparatus, such as synchronous rectifiers, resistance and inductance units and the methods of their use in laboratory work to ensure increased accuracy —largely through increased sensibility to small currents.

The Standardization Committee submitted a series of suggested minor amendments, in the shape of additions as well as changes in wording, to the Standardization Rules of the Institute. These changes were suggested for the most part to definitely fix varying and incongruous nomenclature accompanying recent progress and new apparatus. It was voted to refer the amendments to the membership for expression of opinion.

At one session of the convention the president, Mr. L. B. Stillwell, delivered a sort of informal valedictory dealing with the questions of administration that had demanded attention. Chief among these was the status of sections and branches. The most important step taken was of allowing any section to hold a regular Institute meeting, having the same standing as the regular New York meetings, whenever it should offer for presentation an original paper of sufficient merit to pass the Meetings and Papers Committee of the Institute. President-elect Prof. D. C. Jackson, in a brief salutatory, outlined his ideas about the next administration —notably in regard to ways and means of making permanent the present interest in and the influence and responsibilities of local sections, always with due regard to centralization of control. For a couple of hours following, the delegates of local sections were given the floor to express their ideas of how the local and general interests of the Institute could best be served.

The question of professional ethics of consulting engineers was casually mentioned at this session, and Mr. F. J. Sprague, New York City, protested against the readiness of manufacturing companies, in their attempts to "get business," to make free reports on power development or power utilization schemes which should first be examined by an independent expert. He stated that through the efforts of President Stillwell, largely, the prominent manufacturers had agreed to conform to any broad requirements which the Institute might establish. A special committee now has this somewhat delicate task in charge.

THE STUMPF MID-CYLINDER EXHAUST ENGINE is described at length in an illustrated article in "Engineering" (London) for June 10, 1910. This type of engine, designed by Prof. J. Stumpf, of the Technical High School, Charlottenburg, Germany, differs from the ordinary steam engine in having its exhaust ports at the mid-length of the cylinder.

Steam is admitted alternately at the two ends of the cylinder through poppet valves. The piston is of a length only a little less than half that of the stroke. Thus at the crank-end of the stroke, when one face of the piston is within the clearance distance of the crank-end of the cylinder, the other, or head-end, face of the piston is just past the cylinder's mid-length. In this position, the grated, annular exhaust port is open and exhaust occurs. Compression begins as soon as the piston has passed far enough in its return stroke toward the head-end to close the exhaust ports. Thus the piston acts as its own exhaust valve.

By this arrangement, the flow of steam through each half of the cylinder is always in the same direction, that is, from the end toward the middle. The middle of the cylinder is kept always cool in comparison to the ends. Of the steam in the cylinder when release occurs (at about .9 stroke) the coolest, and therefore the wettest is rejected through the exhaust ports. The steam entrapped and compressed will be dryer, some of it in fact superheated by the steam-jacketed cylinder head.

It is claimed that this engine is better able than the ordinary type to take advantage of high degrees of superheat and high vacuums. With exhaust at .05 of an atmosphere (vacuum 28½ ins. of mercury), the clearance, it is said, need be only 1½%. For atmospheric exhaust, the necessary clearance amounts to 16%. The economy of simple engines of the Stumpf type is stated to be equal to that of an ordinary triple-expansion engine working with saturated or superheated steam.

A water rate of not more than 8.8 lbs. per HP.-hr. is guaranteed. Tests made in February, 1909, by the Elsassische Verein der Dampfkessel Besitzer, on a 500-HP. Stumpf engine gave results as follows:

Admission pressure	170 lbs.
Exhaust pressure, absolute	2.06 lbs.
Admission temperature	581° F.
R. p. m.	121
I. HP.	503.1
Mechanical efficiency	92.5%
Steam per I. HP.-hr.	10.14 lbs.

In this test the engine was at a disadvantage due to a small-diameter pipe system and the comparatively high back pressure, which was caused by an oil separator in the exhaust line.

A large number of Stumpf engines have been built and put in operation in Germany and they are now being made by four different British firms. They have been or are being built as stationary engines, locomotives, winding engines, rolling-mill engines, blowing engines, portable engines, and air compressors.

A Road Roller of Improved Design with Novel Form of Front Truck.

Road roller construction in general has reached a point where a more or less definite standard of design has been developed. Rollers of different make differ mainly in workmanship and in minor details of construction. The front fork, or Y, by which the weight of the forward end of the boiler is carried to the axle of the front roll or rolls is a feature common to the great majority of modern road rollers. This fork has to be arranged so as to permit the front axle to turn in a horizontal plane, for steering, and also in a vertical plane to accommodate irregularities in the road. The Geiser road roller, shown in the accompanying illustrations, embodies a number of new departures in design, of which the most radical, perhaps, is the design of the front truck.

Front Truck.

A glance at Fig. 1 will reveal the new scheme for connecting the front roller with the body of the machine. The ends of the front roller axle are secured to a horizontal turntable frame encircling the front rolls and carrying bearing rollers which engage suitable tracks in an outer frame. The outer frame has an A-shaped portion, extending in a horizontal plane toward the rear, and pivoted at its apex to the body of the machine. This arrangement, besides giving greater stability than the fork truck and affording no obstruction to cleaning the flues from the front end, makes possible a positive steering mechanism much more satisfactory than the somewhat uncertain tiller chains ordinarily used.

The general arrangement of the front truck is shown in Fig. 2. The two turntable frames encircle the front roller in a horizontal plane passing through its axis. Two sets of bearing rollers are provided—one set on horizontal axles and the other on vertical. The rollers of the first set engage the upper and lower edges of the outer turntable frame and are arranged in four groups of four rollers each with two rollers in each group above the frame and two below the frame. The rollers above the frame are called into play only occasionally. The second set (with vertical axles) contains eight rollers arranged in four equally spaced pairs. The rollers in each pair are placed side by side, with about 15 ins. between centers of axles, and these pairs are placed midway between the groups of the first set. The second set of bearing rollers serves to keep the front main roller centered in the yoke and takes up the strains due to the road resistance.

The A-frame is rigidly attached to the outer ring of the turntable and is pivoted at its apex to a bracket on the front of the firebox. The front end of the boiler is supported on a bracket leg bolted to the boiler shell and pivoted at its foot to a pin in the cross-bar of the A-frame. The pin is in line with the one at the apex so that the whole turntable frame is free to turn on an axis parallel to, and directly below, the center line of the boiler, thus enabling the front rolls to accommodate themselves to inequalities of road surface.

ADVANTAGES OVER FORK TYPE.—The ordinary form of front truck arrangement is shown diagrammatically in Fig. 3 for convenience of comparison and to show by contrast the advantages resulting from the new arrangement. With the fork type (Fig. 3), the front end of the boiler is obstructed to such an extent as to make it extremely difficult if not almost impossible to clean the flues from this end. The Geiser construction leaves the front entirely unobstructed.

Other advantages, of which stability is the first, result from the bringing of the horizontal axis of the truck nearer to the ground. In the fork truck, as shown in Fig. 3, the horizontal axis is a pin joint at the point where the stem of the fork joins the arms. This joint must of necessity be a few inches at least above the highest point of the roll. The turntable truck construction thus reduces the height of this axis from the ground by a little more than one-half.

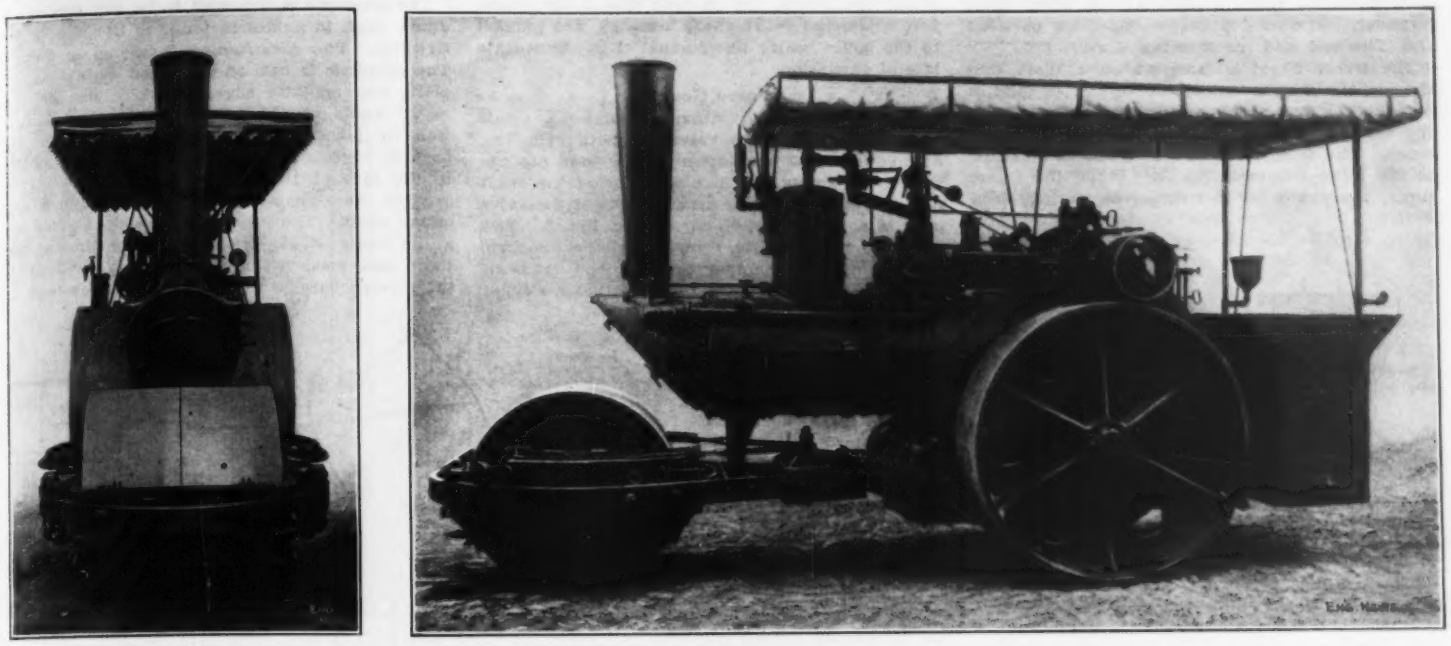

FIG. 1. A 12-TON ROAD ROLLER WITH A NEW TYPE OF FRONT TRUCK AND SMALL WIDTH ACROSS REAR ROLLERS.

This insures at least twice as great stability on side slopes, on bumpy ground and in making turns. The side-sway of the forward end of the boiler on uneven roads is reduced in the same ratio, giving greater immunity from danger to the engine through priming.

In the fork type of truck, a considerable bending load is unavoidably brought into action on the fork and tends to cramp the upper stem in its bearings. The forward shove of the body of the machine acting through the fork stem bearing on the front of the boiler, and the road resistance acting on the under side of the front roll, form a couple tending to bend the lower end of the fork back under the machine. When one of the tiller chains, attached usually to the lower ends of the arms of the fork just above the axle, is brought into action, it adds another force which tends to aggravate the bending and which increases with the turning friction.

No such cramping effect can be produced in the turntable truck. The point of application of the forward shove is in the same horizontal plane with the front axle so that there could be no tendency to cramp even were the possibility of such a thing not practically eliminated by the use of the turntable instead of a journal bearing.

Steering Gear.

The arrangement of the new truck makes convenient the application of a further improvement in the form of a positive steering gear. In the plan view, Fig. 2, the tiller rod can be seen at the left extending down between the right-hand driving roller and the boiler jacket. A series of universal joints connects the lower end of the tiller rod with a worm shaft mounted on the A-frame of the truck near its apex.

A special connecting arrangement is made necessary by the relative movement between the main body of the machine and the truck frame when traveling over uneven surfaces. The tiller rod, through a simple universal joint, drives a short horizontal shaft set at an angle of about 21° with the axis of the boiler. This 21° stub shaft is mounted in bearings which are fixed to the same bracket that supports the apex bearing of the A-frame. The worm shaft is set at the same angle (21°) as the stub shaft. The adjacent ends of the stub and worm shafts carry universal joints which are joined not by a rigid shaft but by two links jointed to each other and with their other ends jointed to the center blocks of the worm and stub universals. These two links have a combined length greater than necessary to span the gap between the two universals, and they consequently project out sideways in the form of a V. This duplex universal joint gives the required flexibility for the weaving

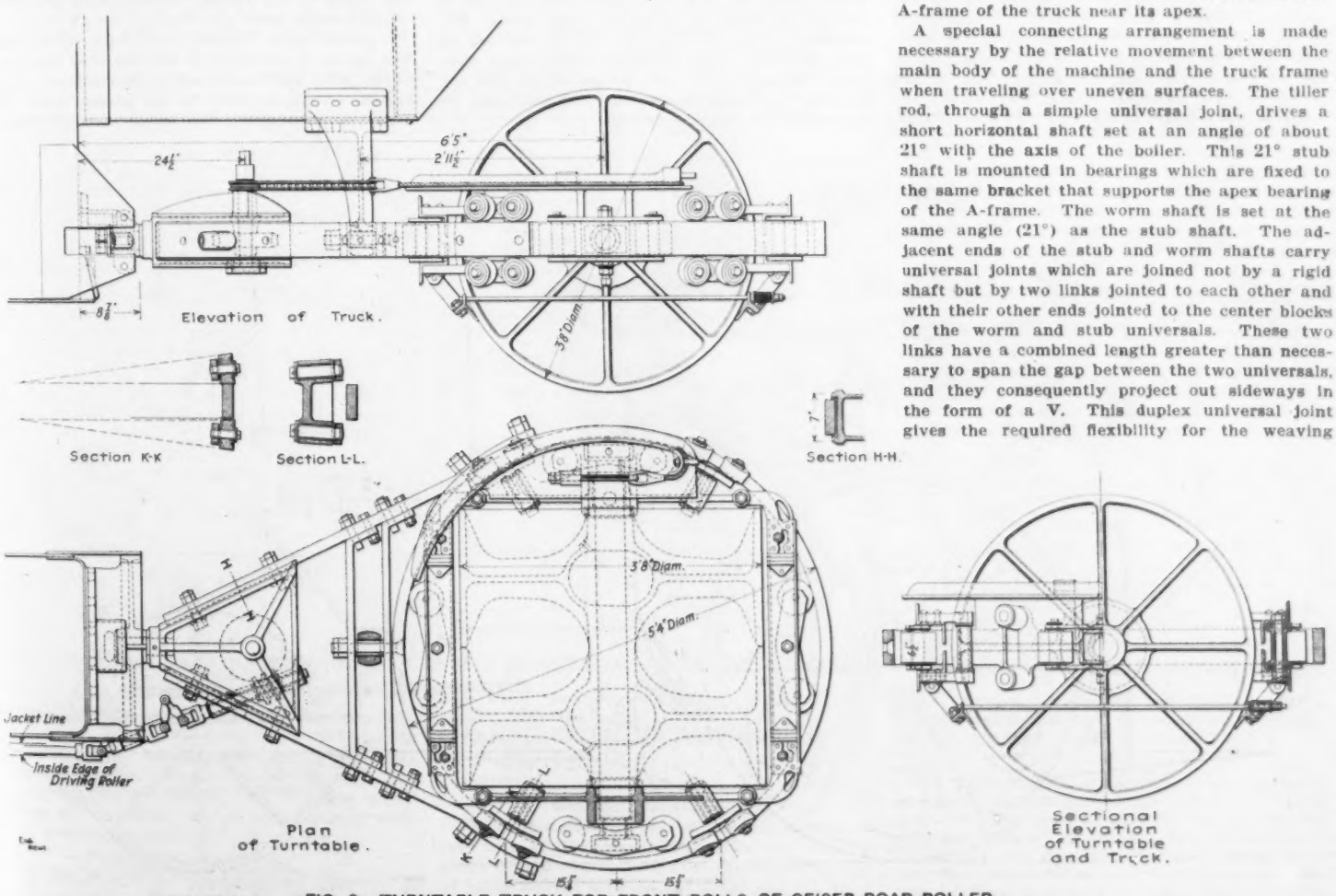

FIG. 2. TURNTABLE TRUCK FOR FRONT ROLLS OF GEISER ROAD ROLLER.

motion of the front truck. At the same time, however, it forms a positive connection between the tiller rod and the steering worm.

The worm wheel is mounted on a short vertical shaft which carries at its upper end a sprocket pinion meshing with the roller chain, the ends of which are fastened to the two tiller ropes. The tiller ropes are wire cables attached to the inner turntable frame. When the frame turns, the cables wrap themselves on long iron

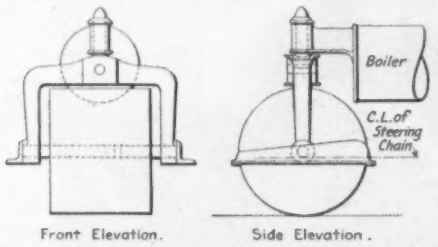

Fig. 3. Common Type of Front Truck for Road Rollers.
(For comparison with the Geiser truck.)

segments of angle-shaped section which keep the cables from coming in contact with the edges of the front rolls in making a turn. The transmission chain which joins the cable ends is kept taut so that the slack motion is reduced to a minimum.

Engine Frame Mounting.

The roller is driven by a two-cylinder engine with cranks at 90° mounted on top of the boiler near the rear. The engine frame is mounted on the boiler with flexible connections which relieve the strains that would otherwise result from unequal expansion of the engine frame and boiler casing. Connection is made by means of vertical pieces of ¼-in. boiler plate bolted to the engine frame above and to brackets on the boiler casing below. These vertical pieces bend slightly to neutralize the greater expansion of the boiler and no serious stress is transmitted to the engine frame. The frame is connected to the boiler at three points. The forward connection is shown in Fig. 4 just below the valve-rod stuffing box. The flexible plate of this connection is set at right angles to the center line of the boiler so that it takes up the longitudinal expansion. The plates of the two rear connections, which are located one on each side of the frame, just below the crank-shaft bearings, are parallel to the boiler center line so that they compensate lateral expansion.

Valve Gear.

The valve gear is rather unusual. A single eccentric actuates the valves of both cylinders, and both cut-off regulation and reverse are obtained by sliding this eccentric across the shaft in a straight line. The arrangement of the valve gear is shown diagrammatically in Fig. 5. Two eccentric rods radiate from the single eccentric strap which is common to both and transmit their motion to the valve stems of the two cylinders through rocker arms. One eccentric rod rises above the center line of the engine at an angle of about 39° and the other is depressed below the center line at an angle of about 51°. The angle between the mean directions of the two eccentric rods is 90°. This arrangement necessitates a wrist pin connection between one of the eccentric rods and the strap, as shown on the lower rod.

It will be seen that with the angle of 90° between the directions of the eccentric rods the relation of travel of the two valves is the same as for parallel rods driven by two separate eccentrics set at 90° apart. In a double engine with cranks at 90°, the two eccentrics in the ordinary arrangement are also at 90°. If the end of one eccentric rod is swung up and the end of the other down, one eccentric will have to be retarded and the other advanced, each by an angle equal to that through which its rod is swung, in order to keep the same steam distribution. By swinging the end of one rod up and the other down through angles such that their sum equals 90°, the centers of the two eccentrics are made to coincide and they can be replaced by a single eccentric.

The eccentric is arranged to be slid across the crank shaft in guides fastened to the web of the flywheel. The construction is shown in Fig. 6. The eccentric is cast in one piece with a square plate, two opposite edges of which are beveled to an angle of 45°. The flywheel has a disk web in place of spokes, and guides for the beveled edges of the eccentric plate are bolted to the face of the web. The eccentric has a grooved cross-piece which passes through a slot in the shaft. The grooves of the cross-piece are at an angle of 45° with the center line of the shaft and mesh with corresponding grooves in the reverse bars, which lie in the hollow end of

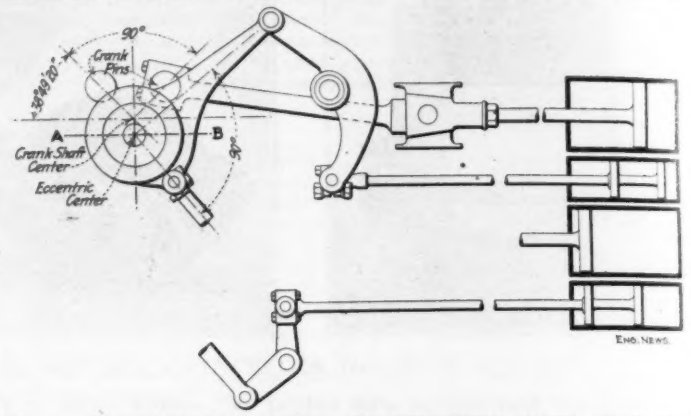

FIG. 5. DIAGRAMMATIC SKETCH OF REVERSING VALVE GEAR FOR ENGINE OF GEISER ROAD ROLLER.
(Eccentric shown in mid-gear position. Reverse is obtained by shifting the eccentric across the shaft along the line A B.)

the shaft. The reverse collar is connected to the reverse bars by a rectangular pin working in a slot in the shaft. By moving the reverse lever (not shown in Fig. 6), the collar is slid longitudinally along the shaft and carries the grooved bars with it. The bars act on the grooved cross-piece of the eccentric and the eccentric plate is slid along in its guides. Intermediate positions of the reverse lever give various cut-off ratios.

A piston valve is used, with inside admission. The steam distribution is the same as that obtained with shifting-eccentric flywheel-governors except, of course, that in the present case the range through which the eccentric is shifted is

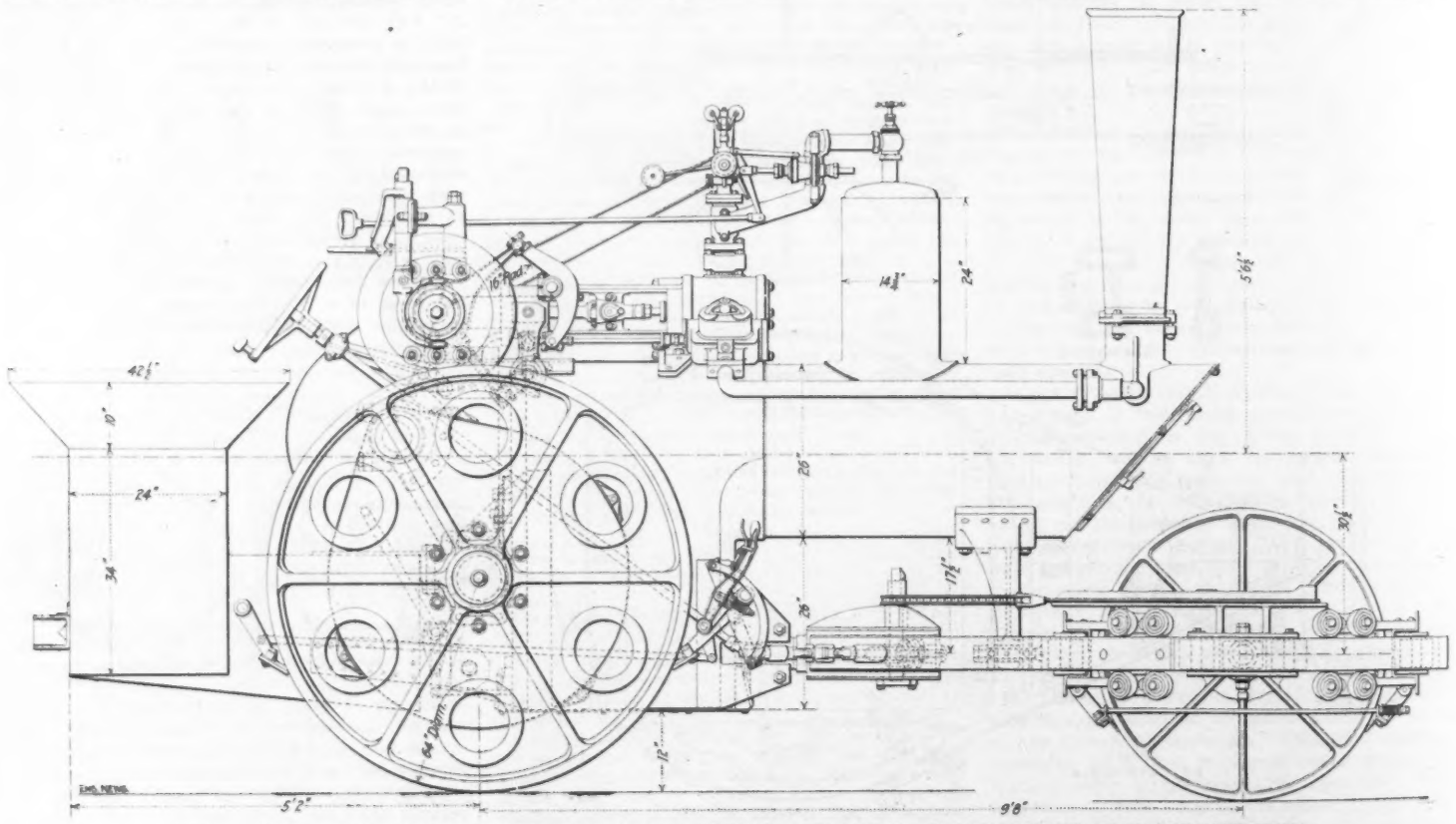

FIG. 4. SIDE ELEVATION OF GEISER ROAD ROLLER SHOWING FRONT TRUCK AND VALVE GEAR ARRANGEMENT.

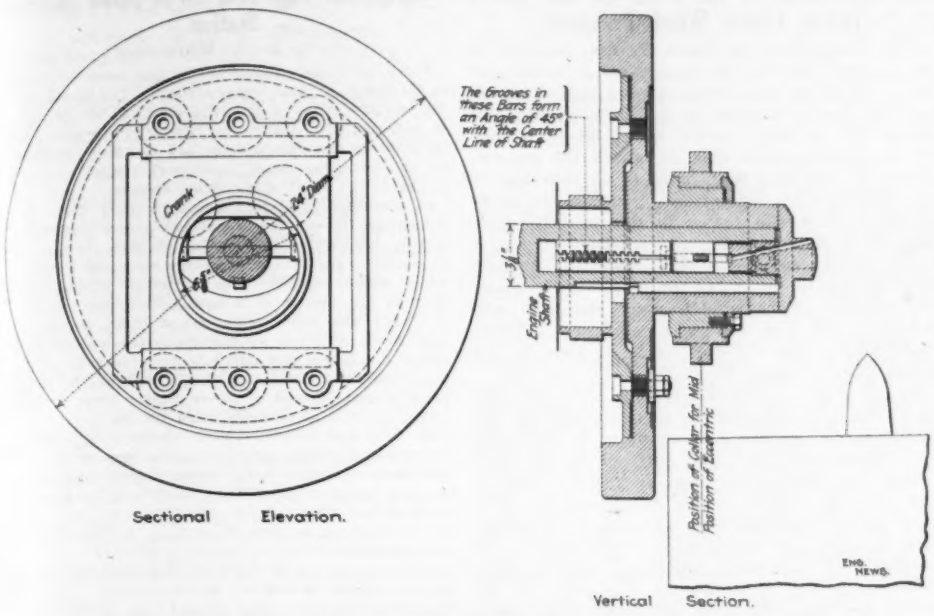

FIG. 6. THE SHIFTING ECCENTRIC OF THE GEISER ROAD-ROLLER ENGINE.

much larger. It will be noticed in Figs. 5 and 6 that the direction in which the eccentrics is shifted forms angles of 39° and 51° respectively with the positions of the two cranks, but, when compensation is made for the divergence of the eccentric rods, it is found that the effect in both cases is the same as though the eccentric of an ordinary gear were shifted in a direction at right angles to the crank position. Therefore, when the eccentric is shifted, the eccentricity and angular advance are both changed in such a way as to give variable cut-off with constant lead.

As designed, the latest possible cut-off is 68.8%. The cylinders are 6 ins. in diameter by 7½ ins. stroke and the engine is run at 280 r. p. m. With a boiler pressure of 160 lbs., the horsepower at latest possible cut-off is 72. The boiler is 26 ins. in diameter, with 59 flues of 1½-in. diameter and 51 ins. long. The total heating surface is 121½ sq. ft. and the grate surface is a trifle more than 4 sq. ft. The boiler can be fed by either one of two injectors with ¾-in. pipe connections.

Compensating Gear.

The differential or compensating gear is so constructed that the driving power is transmitted through flat springs in torsion which equalize the distribution of load on the pinions and protect them from damage by sudden shocks.

The master gear (Fig. 7) is bolted to the driving roller and is driven by the countershaft pinion which is cast in one piece with the gear wheel X. The gear X meshes with the four pinions B mounted in boxes carried in the large counter gear wheel. The counter gear meshes with the pinion (not shown) on the engine shaft. Turning in the same bearings with the pinions B are four gears A meshing with the large internal gear which is keyed to the countershaft. Instead of being rigidly connected to the pinions B, the hollow stub shafts of the gears A turn freely in the corresponding sleeves of the pinions and can exert a torque on them only through the flat springs whose opposite ends are fastened in slots in the pinions and gears respectively.

General Arrangement.

The countershaft is placed far enough toward the rear of the machine so that the counter gears can be moved in behind the boiler instead of being located between the boiler and the inner edges of the driving rolls. This enables the rolls themselves to be brought closer together than with the ordinary arrangement for double-drive machines and reduces the width from outside edge to outside edge of rolls by twice the width of face of the counter gear plus the necessary clearances. This amounts to about 8 ins. The compactness of this arrangement is well brought out by the end view in Fig. 1.

The narrower width enables the roller to be used on narrower roads. The minimum width of road that can be rolled, when it is required that the rear rollers shall be passed over every inch of the road's width, is equal to twice the distance between inside edges of the rollers plus the sum of their widths. Therefore any reduction in width between inside edges reduces the minimum width of road that can be completely rolled by twice the amount, or in this case by about 16 ins. The minimum width of road for this roller (12 tons) is 8 ft. 8 ins.

Each driving roller has a width of face of 20 ins. and a diameter at the outer edge of 64 ins. The length of the roller over all is 18 ft. 3¼ ins. The diameter of the rear rolls at inside edge is 1 in. less, giving a slight taper or cone-shape which makes the roller conform better to a crowning road surface. In working conditions, with boiler and coal box filled, the roller exerts a pressure of about 5¼ tons on each rear roll and 3¼ tons on the two front rolls. With the engine shaft running at governor speed (280 r. p. m.) the roller has a speed of about 2⅞ mi. per hr. It has sufficient power to pull a road grader or a rock crusher, and a pulley with 9-in. face is provided which can be mounted on the engine shaft and belted to a stationary rock crusher. For stationary work the engine-shaft pinion is slipped out of gear and the pulley slipped on the shaft with its overhanging face encasing the pinion, and with its hub against the pinion. The belt is run backward over the left-hand coal box, which is made collapsible.

These rollers are made by the Geiser Manufacturing Co., Waynesboro, Franklin Co., Pa. Patents on the various new features have been obtained or are now pending.

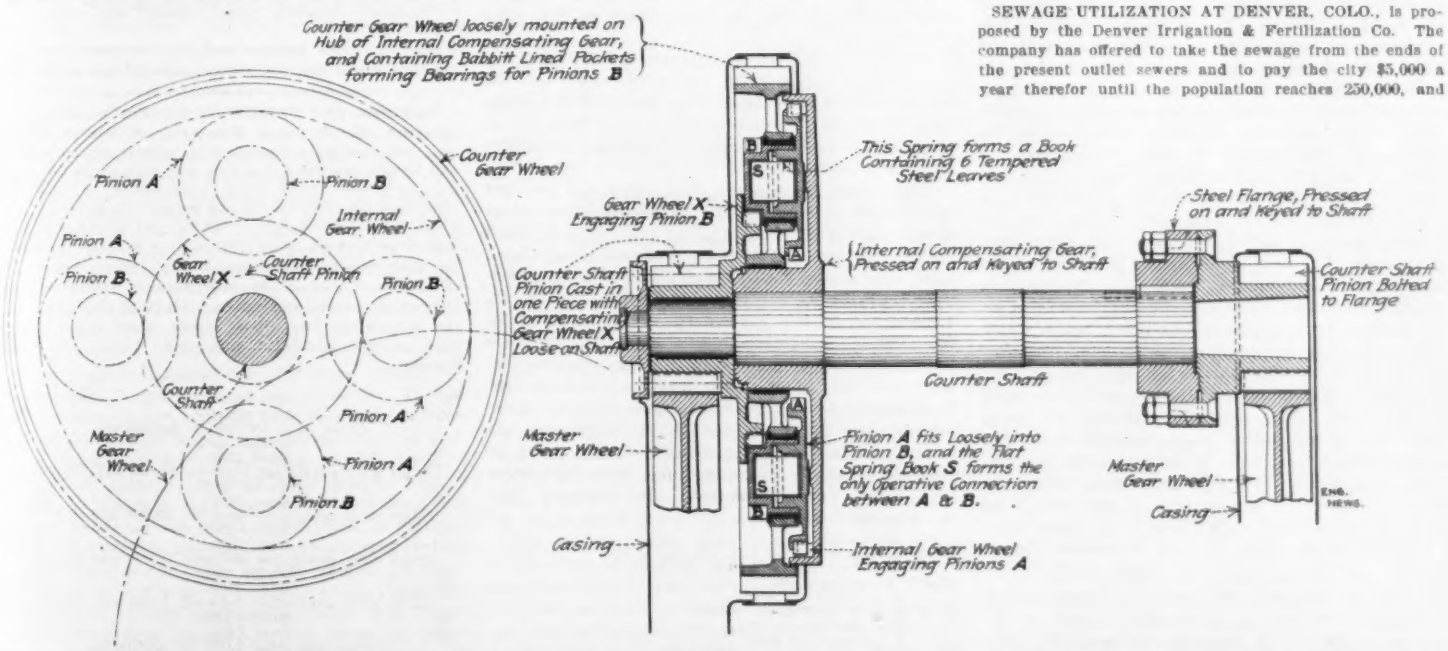
Counter Gear Wheel loosely mounted on Hub of Internal Compensating Gear, and Containing Babbitt Lined Pockets forming Bearings for Pinions B
Counter Gear Wheel
Pinion A
Pinion B
Internal Gear Wheel
Gear Wheel X
Counter Shaft Pinion
Counter Shaft
Master Gear Wheel
This Spring forms a Book Containing 6 Tempered Steel Leaves
Gear Wheel X Engaging Pinion B
Steel Flange, Pressed on and Keyed to Shaft
Internal Compensating Gear, Pressed on and Keyed to Shaft
Counter Shaft Pinion Cast in one Piece with Compensating Gear Wheel X Loose on Shaft
Counter Shaft Pinion Bolted to Flange
Counter Shaft
Pinion A fits Loosely into Pinion B, and the Flat Spring Book S forms the only Operative Connection between A & B.
Casing
Internal Gear Wheel Engaging Pinions A
ENG. NEWS.

FIG. 7. COMPENSATING OR DIFFERENTIAL GEAR OF THE GEISER ROAD ROLLER WITH TRANSMISSION THROUGH SPRINGS TO ABSORB SHOCKS.

SEWAGE UTILIZATION AT DENVER, COLO., is proposed by the Denver Irrigation & Fertilization Co. The company has offered to take the sewage from the ends of the present outlet sewers and to pay the city $5,000 a year therefor until the population reaches 250,000, and $1,200 additional per year for each 50,000 increase in population. The ordinance embodying this proposition has been introduced in the City Council.

THE FREIGHT-CAR SITUATION is still practically unchanged, the movement of late summer not having begun yet. The report for June 22, just issued by the American Railway Association, shows a surplus of 125,644 cars, only about 4,000 less than two weeks before. Box cars make up about half the surplus. One year ago (June 23, 1909), there was a surplus of 263,000 cars.

Francis M. Ferguson.

Francis M. Ferguson, who died June 22, 1910, represents typically that newer generation of contractors which marks the present practice of construction work in this country. While yet a relatively young man at his death, he had directed a great amount of contract work, chiefly in railway construction, and through his organizing talents had built up a large and successful system.

His life work absorbed him intimately up to the moment of his death and, indeed, indirectly led to his death. Visiting Denver to bid upon a large railway construction contract, he had only just put in his proposal when the effect of the altitude upon his heart took hold of him and caused his death on the same day he had submitted his bid.

Mr. Ferguson was the son of Oliver Ferguson, a large railway contractor. Born in Corydon, Wayne County, Ia., Oct. 1, 1863, and educated in the primary school only, he early set to work in his father's construction gangs, until in 1889 he became his father's partner, when they organized the firm of Oliver Ferguson & Son. This firm continued and extended the railway contracting operations of the elder Ferguson. In 1896 (after the latter's death) Francis Ferguson moved to New York City and there organized The Ferguson Contracting Co., one of his associates being James Gilfillan, Ex-Treasurer of the United States, and up to the present time treasurer of the new company. The work of the company was rapidly extended, and in the 14 years since has averaged annually several million dollars' worth. Mr. Ferguson throughout was the organizing and directing head, and by his executive abilities largely determined the company's success. The following notable items of work may be mentioned among those done by the company:

Twelve miles of construction on the Wabash Ry. Pittsburg Extension, including several tunnels, chief among them the 3,333-ft. tunnel on the north shore of the Monongahela—an enterprise averaging over $400,000 per mile in cost; 28 miles of construction on the West Side Belt R. R. at Pittsburg; 20 miles on the Pittsburg, Bessemer & Lake Erie; a 15-mile section of the Erie Ry. improvement above Port Jervis—the Erie & Jersey R. R.—where heavy grading was the rule and one cut contained half a million cubic yards; sections of 20 to 40 miles on the Greenbrier Extension of the Chesapeake & Ohio, on the Chesapeake Beach, and on the Detroit & Lima Northern; extensive second and third-tracking on the Baltimore & Ohio, on the Pennsylvania between Pittsburg and Ashtabula, and on the Franklin & Clearfield Division of the Lake Shore; and among work still uncompleted, a total of several hundred miles of relocation on the Kansas City Southern and the Atlantic Coast Line, 15 miles of construction on the Winston-Salem Southbound, and three sections of the New York, Westchester & Boston suburban rapid transit line. The company carried out some large river and canal improvement contracts, among them three levees at Bolivar Loop, Helena, Ark., and Greenville, Miss., totaling about 6,000,000 cu. yds., and a section of the New York Barge Canal. The construction of more than a hundred miles of gravel road in Indiana should also be numbered among its larger works.

It will be apparent that extensive organization and broad abilities in management were requisite to conduct such business successfully. Mr. Ferguson's organizing and directive skill was a chief factor, and it was the man's distinguishing mark. Throughout his career he was a leader in the adoption of advanced methods in contract work. He was markedly progressive in introducing special machinery for concentrating output.

Mr. Ferguson was married in 1905 to Miss Bertha Sweeney, of Pittsburg, who with a young daughter survives him. He was a member of several clubs and had a wide acquaintance in railroad and contracting circles throughout the country.

The Movement of the Peak of the Eiffel Tower Under Wind Pressure.

The Eiffel Tower at Paris, France, as most of our readers know, is a framework of structural steel formed by four corner towers spaced at the bottom on the corners of a 320-ft. square and rising into a single tower about 50 ft. square at its summit, some 1,000 ft. above the ground. Owing to the fact that there is no covering to the framing as in the ordinary building, the effect of wind upon the tower is not exactly comparable to that in standard construction, but it is interesting to record that observations show that the movement of the top of the tower under the pressure of the wind is much less than was computed by the designing engineers. These observations were reported by M. E. Bret in "Le Genie Civil," March 12, 1910.

In the original computations for wind pressure the wind was regarded as pressing against the actual surface of the steel members in the plane first encountered plus the surfaces of the rear planes not covered by those in front. This it will be seen, gives a very much smaller area than the total exposed area across any one plane, such an area, for instance, as would have to be considered in a walled building. Under these assumptions the deflection of the peak of the tower for three different conditions was computed to be as follows:

	Deflection. m. ins.
1. Pressure, 61.5 lbs. per sq. ft. at peak, diminishing to 20.5 lbs. per sq. ft. at bottom..	30.8
2. Pressure, 61.5 lbs. per sq. ft. at peak on full height of tower	41.1
3. Pressure, 82 lbs. per sq. ft. at peak, diminishing to 41 lbs. per sq. ft. at bottom	47.4

Observations show that the peak of the tower moves in the general form of an ellipse, the major axis of which corresponds with maximum wind velocity but not necessarily with wind direction, the bracing serving to change somewhat the direction of the bending. The maximum deflection observed was 10 cm., or 3.94 ins., the length of the major axis of the deflection ellipse under a wind storm of about 71.5 mi. per hr., average intensity and varying but little from this mean. In another storm varying from 61 to 67 mi. per hr., with occasional gusts reaching as high as 95 mi. per hr., the deflection was only 2¾ ins.

It was found that only constant winds have a pronounced effect upon the movements of the tower. Sudden gusts of very high velocity serve only to make it tremble but do not cause it to reach as high a deflection as smaller velocities of longer period.

Tests have been made also upon the amount of pressure due to varying wind velocities. Cast iron blocks of different surface area were exposed on the top platform of the tower and so arranged that they would topple over under a given pressure, varying in intervals of 10 lbs. per sq. ft. from 10 to 50 lbs. per sq. ft. The 30 to 50 lb. blocks have never been overturned, although there have been some very severe wind storms; but once has the 20-lb. block been overturned, and that during a very severe tempest. In all other storms only the 10-lb. per sq. ft. block was affected. The conclusion drawn by M. Bret is that the pressures to be expected from wind have been greatly over-estimated. He suggests that the standard formula

$$p = 0.125\ v^2,$$

where p = pressure in kgs. per sq. meter.
v = velocity in meters per sec.
should be changed to

$$p = 0.070\ v^2,$$

or in English coefficients where
p = lbs. per sq. ft.
v = miles per hour,
the corrected formula should read

$$p = 0.0029\ v^2.$$

This reduction in the relation formula between wind velocity and pressure is partly responsible for the discrepancy between the computed and observed deflection at the top of the tower. It is quite probable that in so high a tower the distribution of wind pressure is not as uniform as was assumed by the designers, as noted above. Finally, it should be observed that the unit values of wind pressure assumed, viz., 61.5 and 82 lbs. per sq. ft., is much higher than pressures determined by these or any other experiments.

Equipment and Cost of a Mine Rescue Station.*

By R. Y. WILLIAMS.†

There are certain requirements that must be followed in the design of mine rescue stations. The station building should contain a gas-tight room, 40 ft. long by 20 ft. wide and 10 ft. high. The interior of this room should be fitted to resemble a mine and to afford opportunity for the practicing miner to do work similar to that required in the event of an actual disaster.

In a number of stations already built in this country it has been the practice to divide this room longitudinally and to construct an overcast on one side, the aim being to present a passageway about the room, the travel over which would represent the journey of a rescue party through the entries of a mine. This room should be furnished with mine props and a frame consisting of four pieces of 6 × 8 in. timbers joined together in the shape of a square and tied with two iron rods, in which props may be set and capped with wedges; also brattice cloth, stretchers, and a canvas dummy filled with straw and sawdust so as to weigh about 160 lbs.

In order that men may gain confidence in working in the presence of gas, sulphur candles may be burned in this room to form a choke-damp; charcoal may be fired in open salamanders yielding blackdamp; hydrogen disulphide may be generated producing stink-damp, or ordinary dense smoke may be obtained by burning dampened excelsior.

Adjoining the smoke room and separated from it by a glass partition, should be an observation room where visitors or instructors may sit and view the work of the miners. In this room there should be wall cases in which the rescue apparatus may be hung and protected from dust; there should be work benches to facilitate the cleaning of instruments and the charging of electric safety lamps; and a place to store the cases in which the apparatus is shipped.

Back of the smoke room there should be a lavatory containing toilet, shower-baths and lockers for the accommodation of the miners coming to the station for practice.

A station could be built for $5,000, and equipped for a like sum with a complete line of apparatus, itemized as follows:

12 oxygen helmets, or other suitable breathing appliances.
12 portable electric safety lamps.
12 oil-burning safety lamps.
6 oxygen tanks or reservoirs.
1 oxygen pump.
2 oxygen reviving outfits.
200 potash cartridges.
1 chemical cabinet for gas analysis.
15 cases or trunks for transporting the above apparatus.
Furniture, including chairs, tables, wall cases, etc., tools, supplies, etc.

Thus the three stations could be completely installed [in Illinois—Ed.] for the special appropriation of $30,000.

TO SHOW THE EFFECT OF METERS on water consumption, the Pittsburg Meter Co., of East Pittsburg, Pa., has recently compiled, from special official reports and letters, the number of taps and meters and the average daily per capita water consumption in over 300 cities and towns in the United States. These figures are given in a small pamphlet, which also includes population of each city and an indication of whether the works are publicly or privately owned. The cities are arranged in population groups. We reprint below averages of the per capita consumption for each group of cities, showing the consumption for cities having under 25% of their taps metered contrasted with those having over 75% metered:

No. of cities.	Per cent. of taps metered.	Daily average consumption per capita.
	Cities over 100,000 in population.	
17	Under 25%	182
9	Over 75%	71
	Cities with population between 50,000 and 100,000.	
12	Under 25%	151
7	Over 75%	58
	Cities with population between 25,000 and 50,000.	
16	Under 25%	134
15	Over 75%	57
	Cities with population between 10,000 and 25,000.	
31	Under 25%	154
20	Over 75%	58
	Cities with population between 5,000 and 10,000.	
25	Under 25%	110
25	Over 75%	33
	Cities less than 5,000 in population.	
24	Under 25%	118
35	Over 75%	33

Totals and averages for all the cities tabulated, regardless of population, are not given, nor are there any figures showing the comparative number of private and public plants. As to the latter, we find by our own count that of a total of 317 cities included in the pamphlet, the works in 242 are owned by the city and in 75 by a company. In the second group (50,000 to 100,000 population) only 2 of the 31 cities have works under private ownership.

*Extract from a paper on projected "Rescue Stations in Illinois Coal Mining Localities," read before the Western Society of Engineers in Chicago.
†U. S. Geological Survey.

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Bearing on our last week's note concerning railway signaling, recent figures received from the Pennsylvania railway system on results of its regular "efficiency tests" show conditions closely nearing perfection. All the published figures, from this as well as from other railways where discipline testing is practiced, show a progressive improvement, we believe, tending toward a very satisfactory condition. Unless this showing is altogether misleading, it means that by training and inspection it is possible to render the human factor in railway operation highly reliable.

Inasmuch as one great complaint of American railway operation has been the uncertainty of the human element of the operating machine, such a condition is notably a cause of gratification. It has long been thought necessary, and increasingly so, that automatic free-from-human-error apparatus must be applied wherever possible, to insure reasonable safety. For example, interlocking plants have been made steadily more elaborate—and in due proportion also more costly. To-day this practice is so advanced that whenever a large interlocking plant is put into service several persons responsible for its working become four or five years older in a few short weeks; not to speak of the fact that the cost of working the crossing eats up the earnings of miles of railway line. Of course, mechanical interlocking is indispensable, for so soon as the variety of combinations at a track focus becomes too large for one man to control mentally, he must take to his aid a calculating machine in the shape of interlocking. But this requirement does not imply all the complication and cost which are currently believed to be the thing, provided only the man remains a reliable thinking part of the mechanism.

There has been a tendency in conducting railway transportation to interchange man and machine, by making the man an appliance for routine work, and making machines to do the thinking. This is a highly expensive procedure, and is not very effective; it is apt to result in two machines, by degrading the man from human function without supplying an iron machine worthy to rank as human. The fact is that the most perfect of these thinking machines sometimes commit errors, and it is fair to ask whether they err less often or less seriously than the man would. If the man can be made highly reliable by inspection, will this not be a cheaper and better-paying kind of inspection than that which is necessary for keeping the mere machinery in efficient working condition?

Mr. George Westinghouse's plea for the establishment of standards in the electric equipment of railways, and especially for the selection of a single type of current supply, deals with a subject that has been under active discussion by railway and electrical engineers for some years past. Such discussion has at no time shown a unanimous sentiment in favor of proceeding at once to formulate standards. Were there only one system of electric supply and utilization, this difference of view might not exist; but there are three, and the question of standardization, therefore, has been more or less intimately mixed up with a dispute between the adherents of the three systems over their relative advantages.

The paper by Mr. Westinghouse, which we abstract in another column, exhibits a strong leaning toward the single-phase alternating-current system; not unnaturally so, in view of the author's connection with the most noted example of single-phase railway operation, namely the 11,000-volt New Haven terminal equipment near New York. We have, however, eliminated, in making our abstract, nearly all that part of the paper which compares the three electric systems to the advantage of the single-phase system, and have endeavored to bring out alone the plea for promptly taking up the task of establishing a universal standard for railway electric equipment. For, this is expressedly the purpose and central feature of the original paper, and to all those who are not directly concerned in the struggle between the different electric systems it will in any event remain the important feature.

Not every voice favors such standardization, as already remarked. Before the same meeting to which Mr. Westinghouse's paper will be presented, an engineer of equal note in the electric railway field, Mr. W. B. Potter of the General Electric Co., will offer a paper whose statements and principles are quite radically different. Witness the following quotations:

> There would undoubtedly be an advantage in having the character of the energy supplied to the contact conductor uniform, but this is out of the question on account of the great difference in the requirements of specific conditions, such as congested urban or suburban service and comparatively infrequent trunk line train movements.
>
> * * * Desirable as would be a standard system for all classes of service, we cannot hope to establish such a standard should it impose an additional expense without adequate return. A summing up of all the elements of each electrical system will generally lead to a definite showing of which system is most desirable to meet specific conditions. For trunk line service a higher potential than 600 volts will unquestionably be used; 1,200 volts direct-current will prove economical in some cases, but a still higher voltage is required to provide economically for the heavier intermittent service. Whether this potential will be 1,800 or 2,400 volts direct-current or 11,000 volts alternating-current cannot be settled arbitrarily.

Incidentally, Mr. Potter is reputed to be an adherent of direct-current operation, as Mr. Westinghouse of the single-phase system. For our present purpose, however, we are concerned only with their disagreement as to the desirability of establishing a standard as soon as possible.

We would suggest that it has not been made sufficiently clear that railway interchange as it exists to-day, if continued in the same way under electric operation, would not essentially depend on standardization of electric supply. Through traffic is almost exclusively a matter of car interchange. There is little or no interchange of locomotives, certainly none that is vitally essential to traffic interchange. But car interchange will depend on the adopted electric system only in the matter of clearances.

Electric operation of trunk-line railways has in all cases been worked out on the basis of using locomotives, and not on the motor-car principle. Leaving out of account a small amount of suburban motor-car operation, the transformation of a railway to electric power leaves the train of cars unchanged and simply places one or more electric locomotives at the head of the train. There are many reasons apparent why this should continue, and why the equipment of all rolling stock with motors and control system, or even with a mere electric train cable, is improbable. If that prove to be the case, then there is no great need to be concerned over the fact that different railways may employ different systems of electric supply. The cars would be able to interchange just as freely as under present conditions, and only the motive power would be restricted to the home line.

In the matter of clearances, we believe some steps have already been taken toward securing uniformity in location of third rail, location of trolley wire, etc. Even if these locations vary, however, they are quite unlikely to cause any trouble in the matter of clearances. The fact that, in some cases of overhead trolley installation, the wire at its lowest points is dangerously near to the roof of high cars, is of no more importance than the fact that tunnel and bridge clearances on some railways are insufficient to pass the largest cars operated by other railways.

On the whole, therefore, it does not appear that the independent electrification of railways here and there under different systems of electric supply is apt to lead to particularly troublesome conditions; certainly no conditions at all comparable in ill effect with those of the time when railway gages varied and when it was found that great expenditures had to be incurred to unify gage in order to permit through operation of cars. Mr. Westinghouse in some paragraphs of his paper, not included in our abstract, holds up these gage troubles as a warning example of what may occur in the future if electrical standardization is not promptly undertaken. This view seems unnecessarily pessimistic.

The committee report on licensing civil engineers which was submitted to the convention of the American Society of Civil Engineers at Chicago the last week in June (Eng. News, June 30, 1910, p. 761) is commendable for the high ideal which it presents. While we would not even suggest that the ideal is too high we feel it our duty to point out that little in the way of tangible results is likely to come from the report until much additional study has been devoted to the task of formulating a single licensing scheme adaptable to all classes of engineers save the military and acceptable to the legislatures of 48 sovereign states.

As bearing upon this question we would call attention to the fact that the burden of the presidential address delivered at the convention to which the licensing report was submitted was the need for cohesiveness and united effort on the part of engineers. The president was a member of the committee on licensing engineers, but the report of the committee never hinted at the existence of other national engineering societies, although proposing to license as civil engineers all engineers other than military or exclude them from state recognition as engineers. Such an attitude does not conform very well to the idea of cohesiveness, or the solidarity of the engineering profession. A suggestion for cooperation with the other national engineering societies, and for that matter with the state and still more local societies, could have done no harm.

Before satisfactory legislation in any single state, much less uniform enactments in 48 states, can be secured it will be necessary for some one man or group of men to make a careful study of the fundamental principles involved in licensing engineers, as well as of the differing conditions affecting the practice in various parts of the Union. In trying to work out, first, an ideal plan for licensing and, second, a practical modification which will adapt the plan to the different states and provide machinery for its execution, it would be helpful to study the history and present-day methods of licensing or certifying the members of two other and older professions, those of law and medicine. This and other important phases of the subject might very prop-

erly be studied and reported on by a joint committee of the national engineering societies.

Without such a study and without a united stand on the part of engineers and engineering societies generally the securing of uniform legislation in 48 states would be a long and wearisome task, if, indeed, it could ever be achieved without united action.

As the matter stands to-day an attempt to secure uniform laws for licensing engineers, with interstate recognition of licenses, would very likely result somewhat as follows: In many states the proposed uniform bill would not be accepted, thus resulting in diverse legislation or no legislation at all. In many states where a uniform bill was given a place on the legislative calendar it would be changed more or less before enactment into law. Obviously, unless uniform legislation was secured interstate recognition of licenses would meet with strong opposition in many states, particularly those whose license laws were modeled on a high standard.

In framing and in trying to secure the enactment of a uniform law for licensing engineers it would be well for any one charged with the task to profit by the experience and cooperation of the organization devoted to promoting uniform legislation which has been carrying on a fruitful campaign for a number of years past.

Finally, we again urge the need for broad and deep study of this whole complex problem and urge that in carrying out that study all the influential engineering societies of the country engage in hearty cooperation.

The Peak-of-the-Load Problem.

Thirty years ago "the peak of the load" was a term unknown in engineering science and the problems which it represents were only beginning to arise in engineering work. To-day the expression is familiar to every engineer, or at least to every one acquainted with power-station work, and the peak-of-the-load problem has become important in many diverse fields of engineering.

We owe the expression, it need hardly be said, to the electric lighting industry. As soon as the task was undertaken of supplying electric current for lighting from a central station, it became evident that the capacity of the station to furnish current must be fixed by the moment of maximum demand. The greatest number of lamps used at any time must be the gage in fixing the power of boilers, engines and generators, no matter if a portion of this equipment lies idle nearly all the 24 hours in the day and even most of the year. The expression "peak of the load," of course, came into use from the graphical plotting of the station output. Thus the phrase is significant of the modern application of graphics to every day engineering work and even of the system of automatic recording which has become so important in many fields of engineering. It would be difficult to overestimate how greatly the graphical record has contributed to the clear understanding of engineering problems; and clear understanding is the first step necessary for correct solution. No words and no table of figures can express so forcibly the situation of an electric station as the single black line which shows its output from the beginning to the end of the 24 hours. This line it is, with its sharp mountain summits and broad valleys which has given rise to the significant expression, "the peak of the load."

It has seemed to us worth while to point out that with the modern development of industry and transportation, the problem of how to take care of the peak load has become a problem of first importance in many lines of engineering besides the power stations where the term "peak load" was born.

One example is the suburban passenger traffic which has reached such large proportions around the great cities. The commutation fares by which this suburban traffic has been built up have remained unchanged in many cases for more than a quarter of a century. Now, however, the railways have undertaken a radical advance in these fares. The reason given is that a very large equipment of rolling stock and employees must be provided to handle the traffic in the rush hours of morning and evening and has to lie idle the rest of the 24 hours. In other words, we have the problem of the electric station over again: How can we economically carry the peak load?

Problems very similar press hard all through the railway field. Happy is the railway manager whose traffic flows evenly all through the 24 hours of the day and the 365 days of the year. Few indeed are the places where such ideal conditions prevail. In the passenger department, the rush of summer excursion travel must be carried in comfort, even if cars stand idle the rest of the year. The regular passenger trains must have cars enough the year round to provide all passengers with seats on the days of heaviest ordinary travel, even though these cars run half or three-quarters empty on days when travel is light.

In the freight department, cars and locomotives must be ready for use so that crops can be promptly moved in the fall, even though they stand on side tracks the rest of the year. At one time cars must be concentrated in one section to move in a few weeks the entire Georgia peach crop. Again the demand comes from the orange growers of California, or the melon raisers of Colorado. Even such staples as coal and ore and stone have their seasons of movement.

In ocean transportation; the peak load problem is even more serious than in land transport. By far the greatest ocean passenger business in the world is the travel across the Atlantic between Europe and the United States. This travel tends more and more to become concentrated in the summer months. In May and June and July Americans swarm toward Europe and crowd the space in every available steamer. In late August and September there is eager competition for space in steamers homeward bound. The steamship companies are anxious to carry the peak of the load; but what to do with ships and men during the remaining seven months of the year is the puzzling problem. The winter tourist excursions to tropical waters are an attempt of the steamship companies to solve this problem.

In ocean freight traffic, too, the variation is great notwithstanding the fact that tramp steamers can go anywhere to seek business, so that the falling off in traffic from a country at one season may be offset by heavy traffic in some other part of the world.

What breaks the heart of the steamship owner is the seasons when freight business is slack the world over and under the stress of competition freights go down to a point where it is more profitable to tie up a boat than to send her on a voyage.

In manufacturing, the peak load problem is as prominent as in transportation. When the railway business is slack, railways will not buy cars or locomotives. When the rush of traffic comes, orders flow in faster than they can be filled and shops work overtime. The shipbuilding industry at its greatest center of activity, England, has periods of depression and activity closely related to the corresponding periods in the business of ship owning and operation.

Even in the staple industries production has its seasons of briskness and of slackness. It is an old saying attributed, we believe, to Mr. Carnegie, that the iron trade is either a prince or a pauper. A chart of pig iron prices for the past forty years shows a succession of high peaks and deep hollows. When prices are high a blast furnace yields to its owners an enormous percentage on its cost. It may even earn profits equal to its entire cost in a year or two. When prices are low, the margin of profit may entirely disappear and compel the furnace to be blown out as the only alternative to bankruptcy.

With iron as the most important raw material in nearly all lines of engineering construction and manufacture, the influence of such great variations in price is felt all along the line.

The civil engineer engaged in construction is faced by conditions not unlike those met by [illegible] engineer engaged in transportation or in manufacturing. Every civil engineer of mature [illegible] has had his experience of slack times and [illegible] times and has learned to accept with philoso[illegible] the variations of activity that occur annually [illegible] the different seasons of the year. Nevertheless it is a problem which every such engineer frequently studies, how to find employment of some sort for men and machinery during the periods when work is interrupted by the weather.

We might continue to show how in other branches of engineering the same sort of problem occurs; but enough has been said to make it clear that the peak load problem—the task of providing capacity for the time of heaviest demand and doing it without bringing an undue tax on the business—is a problem of enormous magnitude. Is there any waste in the whole range of human industry comparable in magnitude with the waste due to idle capital and idle labor which is idle because it is needed only a small part of the time in which it might be employed? What a huge volume of poverty and distress to the wage earners and consequent crime and disease is traceable directly to the periods of enforced idleness due to this very peak load problem.

Surely no task is better worth the study of the engineer, the economist and the business man than the task of equalizing demand, the task of cutting down the peaks and filling up the valleys of the load diagram.

Of course this can only be partially accomplished at best. An electric light station must furnish its maximum output during the hours of evening lighting; but this does not prevent good managers from increasing the day load by fostering the use of electric motors and heating appliances. Nor does it prevent good engineers from installing storage batteries to aid in carrying the peak load or machinery which can develop a maximum output for a short time regardless of economy.

Some may say that these are problems for the business man rather than the engineer; but we object to any such limitation of the engineer's sphere of work. The greatest men in the engineering profession to-day are the men who are actually tackling these problems which involve questions of business, of economics and of administration, as well as questions of design or construction.

And for the best solution of problems of this sort technical skill and commercial wisdom must join hands. In the problem of earning a profit from suburban passenger traffic, for example, there are possibilities in the way of increasing capacity without correspondingly increasing the cost of service. European street railways have long carried passengers in double-deck cars. An American railway passenger car has nearly a thousand pounds of dead weight for every passenger it seats. Double-deck cars could accommodate a much larger number of passengers with a given dead weight and a given length of station tracks.

Even with the present type of construction better design might greatly reduce the dead weight. Street railways have recently begun to figure on what it costs to carry a pound extra dead weight in a car from the time it leaves the shops, new, until it is finally scrapped. Similar computations for steam railway cars might show the advantage of cutting down in weight at many points by using steel instead of cast-iron and in other ways easily possible. It may be argued that lighter cars would be less safe in the event of collision, but that does not necessarily follow. The heavier a car is made, the greater its inertia and destructive force when collision occurs.

We have said that commercial wisdom is needed. Wisdom that will be as keen to perceive what traffic will not bear without serious falling off in its rate of growth as to find what traffic will bear.

Is the task quite hopeless, either, of developing greater traffic during the slack hours of the day just as the electric light station manager seeks

to encourage the use of motors and electric heaters? Is it a normal and permanent development that has taken place in our great cities, the crowding of business into one central badly congested district and the centrifugal scattering of residents into distant suburbs? Will not, ought not, the future to witness the development of minor business centers around the main center, relieving the crowding at the latter and the pressure upon the traffic routes leading to it? If such development takes place—and there are already signs of its coming—there will naturally be a better distribution of traffic upon suburban lines. Further than this, the railways themselves can exert a strong influence toward bringing about this end by readjusting their freight charges to favor manufacturing and commercial enterprise in suburban districts compared with those in the congested central districts. Such a readjustment is in fact demanded on account of the difference in terminal expenses to the railway companies. As we showed in these columns a few months ago (Eng. News, March 3, 1910) terminal expenses on short hauls are by far the largest item of cost to a railway in handling freight, and this cost is largely ignored in present methods of freight rate making.

We have discussed this matter of the peak load in suburban pasenger traffic merely as an illustration. The point we would emphasize is that the peak load problem—the problem of great fluctuations in demand, in commerce and in production—is a problem to be faced with courage, ingenuity and intelligence. It is essentially a new problem, arising out of the complex and rapid growth of the modern industrial system, and it demands the ablest intelligence of the new generation for its proper solution.

And that solution is not to be found by the man who yields himself without question to the tidal ebb and flow of industry. The manufacturer who lays out all his profits in enlarging his works when times are flush and orders come in faster than they can be filled, often finds himself obliged to shut down his plant or go into bankruptcy when the reaction comes. The railway which accumulates a surplus in good times is able to replenish its rolling stock at low prices when the contract shops are most anxious for orders.

The first step in the solution of any problem is to clearly understand its conditions. It has seemed to us that the above suggestions as to the similarity of the peak load problem as it occurs in many branches of engineering and many industries might aid to its clearer understanding and to profitable solutions.

LETTERS TO THE EDITOR.

The Summer Outing of the American Society of Civil Engineers.

Sir: The Annual Summer Outing of the American Society of Civil Engineers is again happily ended. Golf was not the main feature this year, as it was in 1909, but perhaps the lull is temporary. The relief from technical discussion was everywhere apparent. It saves editing, and the conventions are becoming noticeably less cumbersome. It is believed that the other national societies whose conventions are several times larger than those of the Civil Engineers, may follow the example set by the latter. Should these societies adopt golf as their pastime, the Civil Engineers, in order to maintain their distinction, may return to the national game of baseball, forming competing nines from the "Members" and from the "Associates" and "Juniors" combined.

Member American Society of Civil Engineers.
Boston, June 25, 1910.

Equilibrium Cross-Sections for Large Water-Pipes.

Sir: In the last paragraph in the article "Equilibrium Cross-Sections for Large Water Pipes," appearing in your issue of June 16, discussing a paper recently presented before the American Society of Mechanical Engineers by Mr. R. D. Johnson, of Niagara Falls, N. Y., the statement is made that the author appears to take no account of what would occur in such a non-circular pipe under varying heads and under varying pressures due to earth loads if such a pipe were buried or nearly buried.

Attention should be called to the fifth, sixth and thirteenth paragraphs, appearing in the original article. That there will be deforming stresses due to variations in pressure, backfill and to the weight of the pipe itself is evident. In the paragraphs referred to, the author shows what the bending moments will be under varying conditions of water pressure and gives a method for calculating them. It is, therefore, unfair to say that no account has been taken of what would happen under such conditions. The treatment of combination stresses due to shell and fill is left to the judgment of the designer but is not neglected.

It is true that the ideal condition is found only under a constant head and with a given top fill and weight of shell, but by the use of a form of the curve lying midway between the equilibrium shapes which the pipe tries to assume, under the maximum and minimum pressures to which it may be subjected, the deforming stresses will be smaller than in the case of a circular pipe, and for this reason a considerable saving in material can be effected.

The writer has witnessed comparative tests on large conduit sections of circular shape and of the shape recommended in the article referred to, both being subjected to varying external and internal pressures. The results obtained were strongly in favor of the non-circular shape.

M. C. Hayes, E. E.
Niagara Falls, South, Ont., June 21, 1910.

College Degrees for Engineering Students.

Sir: The letter by "A Civil Engineer," printed in Engineering News of June 23, relating to the subject of college degrees for engineering students, has been called to my attention, and inasmuch as it contains some statements with which I disagree, I am writing to call attention thereto.

The author states that the granting of a professional(?) degree is a joke. The joke is evidently as much on him as on the rest of us who have a professional degree, for he has styled himself "A Civil Engineer." The writer fails to see wherein the joke lies, for he is a firm believer that the degree of C. E., M. E., E. E., etc., should be conferred upon those who have completed the prescribed four-year course and have presented a satisfactory thesis, provided the entrance requirements are high enough to justify such a course. The degree of C. E. or M. E. is conferred upon graduates at the end of four-year courses at Cornell, Columbia and several other universities of similar rank. Surely this is a strong argument that engineering students properly schooled should be fitted to receive a professional degree immediately upon graduation. The majority of the graduates from the higher engineering schools are perfectly capable, after a few years of practical experience, to back with credit their professional degrees.

The author then states very emphatically that the professional degree might be given by colleges or universities in much the same way as the degree of Master of Arts was formerly conferred. The writer cannot understand why "A Civil Engineer" should first say that the professional degree is a joke and in almost the next breath say that it might be conferred upon those who have fulfilled the requirements for becoming an Associate Member of one of the national societies. Being an Associate Member of one of the engineering societies of this country is not always an indication that such a member is thoroughly conversant with the theory underlying his profession, and entitled to a professional degree. The writer can cite cases to the contrary.

The author further states in the first part of his article that the granting of the degree of bachelor in colleges should be dropped, as the title is often assumed by the ignorant and pretentious man, and often conferred on men by friends, as a bit of flattery. Further along in the same article the statement is made that faculties should get together and agree that hereafter the degree for a course in civil engineering will be B. C. E., etc. Surely there is a conflict of statements by the author somewhere. Many colleges and universities used to grant the B. C. E., etc., but have long ago dropped the custom. The writer does not know of a single college, to-day, wherein the degree of B. C. E. might be received, and he has been in personal touch with over one hundred technical institutions in America. There must be some strong arguments for not granting such a degree at present, but the writer has never been able to learn why degrees in such form should not be granted, unless they fail to convey to the average layman that a course in science was pursued with stress placed upon some branch of engineering.

The writer has a degree of "Bachelor of Science in Civil Engineering" and has never yet found it awkward. The proper way to write such a degree is B. S. in C. E. Those who write it otherwise simply do themselves an injustice and purposely want to create the impression that they have pursued a scientific course as well as the civil engineering course. Just because a few wish to misrepresent such a degree by leaving out the little word "in" is no reason whatsoever that the style of the degree should be abandoned. The same argument might be applied to the giving of degrees in general. Just because there is no law to prevent any one from putting a degree after his name, is no reason why colleges should not confer degrees.

Again, the author states that the degree of master should be abolished, and to style a man as Master of Civil Engineering, for instance, would submit him to ridicule. According to such a statement, one of the leading universities of this country has evidently ridiculed over sixty civil engineers by conferring upon them such a degree during its forty-five years of existence. It appears evident to the writer that the author of the article under consideration has not given the subject of higher engineering education the attention that it deserves in the engineering profession or he would not ridicule a degree of Master of Civil Engineering, especially when it represents a step toward the Doctor's degree.

In conclusion, I might say that a master's degree generally takes rank over a bachelor's. And that we judge of the training of man, not always by the degree that he has, but by the college that he has graduated from. Of course this will not always hold good.

It is to be hoped that others will give us some more articles on this important subject. I believe that the titles of the engineering degrees as they are now granted represent forcibly the nature of the instruction given in almost every instance, and that we had better leave well enough alone.

Yours very truly,
Jerome Cochran, C. E., M. C. E.,
Consulting Engineer, Jerome Cochran Co.,
Consulting and Contracting Engrs.
Houston, Tex., June 27, 1910.

More on Reinforced-Concrete Design.

Sir: Mr. Godfrey's paper in your issue of March 31 and his answer to my letter of April 28, which appears in your issue of May 19, both deal with questions of great importance to the designer of reinforced-concrete structures. Nobody reading Mr. Godfrey's arguments can fail to be impressed with the truth of many of his statements; it does not follow that we should accept them all. I still think that Mr. Godfrey is undermining the following perfectly logical elements of the reinforced-concrete theory in common use:

(1) Position of the neutral axis (claimed by Mr. Godfrey to be near the middle of the beam). We have the following expression for the relative depth of the neutral axis when we accept the "straight-line theory"

$$x = \frac{1}{1 + \frac{S}{C\,r}}$$

(see for instance Taylor and Thompson). If now the neutral axis should be located at the middle of the beam we must have $x = \frac{1}{2}$, or $1 + \frac{S}{C\,r} = 2$, hence $\frac{S}{C} = r$. With $S = 16{,}000$ and $C = 500$ this gives $r = 32$ so that Mr. Godfrey tacitly accepts a coefficient of elasticity for concrete equal to 1,000,000, a very odd assumption. The formulas usually used in connection with the straight-line theory permit the designer to select his S, C and r in conformity with his specifications.

(2) The anchorage recommended by Mr. Godfrey is "a threaded end with a bearing washer, and a nut and a lock-nut to hold the washer in place." Is this a joke? Extending the rods a sufficient number of diameters into the next span is sufficient according to all the data I have ever seen; in fact Mr. Godfrey himself says so.

(3) In his ninth point Mr. Godfrey denies the possibility of constructing T-beams. In my notes to this point, I referred not only to my own experience but to that of the profession as a whole. It cannot be denied that innumerable T-beams have been constructed and that they have performed their duty as expected. In his letter of May 19 Mr. Godfrey rejects the value of such experience:

> A structure may be on the verge of failure and remain so for years, and yet it may show no signs of its dangerous condition.

In the Morley Chemical Laboratory, Western Reserve University, I had light T-beams with a clear span of 33 ft.; the entire building was test loaded with twice the specified live load, not, as often done, on small local areas, but several panels entirely covered at the same time in each test. The deflections were quite uniform, about 1/1,500 of the span. There was no visible crack. Will Mr. Godfrey now assert that this building is "on the verge of failure"?

Indeed, I have always believed that one of the "strong points" is the conspicuous evidence of approaching failure. Fortunately I have never had any failures in my own work but I have had some experience with failures resulting from negligence on the part of others. The most interesting example is fully recorded in Engineering

News of Nov. 5, 1908, to which the reader is referred for details. The whole story shows that approaching failure may be detected, the cause analyzed, and the defects remedied with little trouble, although the expense may be heavy.

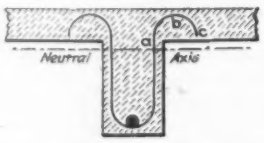
(4) Mr. Godfrey advocates the calculation of the fixed arch by means of methods designed for the two-hinged arch. To this I cannot subscribe. One of the points of "maximum bending moment" in the fixed arch is at the abutment; in the two-hinged arch the moment is of course zero at the hinge, and the hinge is usually placed at the abutment. Hence Mr. Godfrey's method leads him to disregard the bending moment at the abutment—in fact, both abutment and arch-ring are thereby made lighter at this point than required.

These points are all essential ones. The following points I consider as of less importance yet they cannot be disregarded by any means.

(5) Mr. Godfrey asks: "Now what has a designer to do with the 'secondary or tertiary stages?'" Very much, indeed. We know that the concrete has certain minute cracks under steel tension as low as 3,000 to 6,000 lbs. per sq. in. (Bulletin 148, Univ. of Wisconsin), or under concrete stresses as low as 350 lbs. per sq. in. (Prof Talbot; see Buel and Hill, 2d ed., page 31). Hence our designer deals exclusively with the second stage where the concrete has no tensile resistance, as is, indeed, the only rational foundation for any reinforced-concrete theory. When thus the concrete has no tensile resistance, it can be proved that the U-bars act in tension. Nobody will deny that evidence can be found showing the value of U-bars—plenty of evidence. They increase the ultimate strength of the beam except in special cases which can be realized under stationary loads only. I think our duty is not only to design safe structures, but economical structures as well; hence we must use the U-bar and make proper allowance for the increased strength.

The U-bars being in tension, we must anchor them. "How can concrete, even if it were in compression, perform this office?" asks Mr. Godfrey. Well, according to Mr. Godfrey himself, 30 to 50 diameters embedment will suffice to develop the full strength of any bar, why not of a U-bar? There is no difficulty in obtaining any desired length of embedment, measuring along the curved line *a b c* in the diagram appended. A ¼-in. stirrup would require from 8 to 12 ins. embedment; a ¾-in. from 12 to 18 ins.

Mr. Godfrey now asks: "How can it be said that the concrete is in compression in the upper part of the



beam near the support, where the stirrups are most needed?" The old Hennebique patent shows the stirrups inverted near the ends, probably for this very reason. With bent-up rods, in beams simply supported, the top chord is in compression throughout the length of the beam. In the continuous beam, there is indeed tension at the top, near the supports, but would not 30 to 50 diameters be sufficient? We still have the length *a b c* of embedment.

(6) "We all know what is meant by shear in any vertical section of a beam," Mr. Godfrey informs us. The trouble is that we do not. In a reinforced-concrete beam, shear in the first stage and shear in the second stage cannot mean the same, because the ordinary distribution of shear stresses cannot exist in the cracked bottom chord of the beam. Hence the necessity of being explicit and precise when discussing shear in reinforced-concrete beams. Mr. Godfrey is no believer in these "recently discovered cracks"; he thinks it would be a serious matter if they existed:

> Tell a railroad engineer that his bridges are safe if every train that rattles over them opens up new cracks—"recently discovered! cracks"—he will laugh in your face. This is not engineering, it is a defi to Providence and a bid to disaster.

This sort of argument proves nothing. Is Mr. Godfrey ignorant of the memorable scientific war between the French on one side under Considère and the Germans on the other side under Bach? More ink flowed in that war than blood in the last Franco-Prussian war, and arguments were hurled over the border like projectiles. Considère asserted that concrete would stretch about 20 times more when reinforced than when not reinforced. Bach said it would not. The end came in 1907 when Bach gave a long series of test data in Zeitschrift des Vereines deutcher Ingenieure, page 1027, proving conclusively that Considère was wrong. American and other tests have fully sustained Bach's conclusions. [They antedated them by a year or two.—Ed.] All this is old history, connected with the water-marks discovered by Professor Turneaure. We know that concrete cracks, that no economically designed reinforced-concrete beam can carry loads without cracking. The question is no more the existence or non-existence of the cracks, but their significance. And in this latter respect we know that as far as stability and durability is concerned the minute cracks have no significance; they are important only as evidence of a certain change of condition within the beam, a readjustment of stresses. Once this readjustment has taken place, the beam remains in that same condition even if unloaded and reloaded incessantly, because no unloading of the concrete can again unite the separated surfaces and make the cracks grow together. Once cracked the beam stays cracked, whether the railroad engineer referred to by Mr. Godfrey laughs in our face or behind our back.

(7) Turning now finally to the question of the columns, hooped or otherwise, I bow to quote from Mr. Godfrey's paper of March 31 as follows:

> There is no theoretical or practical considerations which would bring in the strength of the hoops after the strength of the concrete between them has been counted.

and:

> and yet, in reading the literature on the subject any one would be led to believe that longitudinal rods and hoops add enormously to the strength of the column.

Yet in the letter of May 19, he says:

> Hooped columns are strong, there is no question about it. And the strength of a hooped column with all its parts properly balanced may be just what the discoverer of the hooped columns found them to be, though his formula is irrational and misleading. But take that formula apart from his work, divorce it from certain fixed proportions of parts to maintain the balance, and error is perpetrated.

Of course. The theory has to be understood in its entirety. Divorce the essential part from the whole and see what happens; divorce the steel from a reinforced-concrete beam; space the hoops a foot apart and the hooped column formula has absolutely no meaning." This was exactly what I had in mind when I criticized the tests quoted by Mr. Godfrey as having no bearing whatever on hooped columns, and also when I made that "astonishing" statement that no one had ever recommended columns "reinforced with longitudinals only." The essential word here is "only"; I really do not recall anyone who ever denied the value of the hoops. I am familiar with tests made around 1900 or so for the purpose of settling this point, and Mr. Godfrey is certainly aware of these tests. They were made by Gary at Charlottenburg (Germany) and may be found in the very first edition of Mörsch's book, 1902.

There is a crying need for reform in much pertaining to reinforced concrete. If Mr. Godfrey can devise means for reforming the owner who cannot afford to pay for efficient and competent engineering, the architect who designs reinforced concrete guided by his ambition and some slight knowledge of structural steel, the contractor who maintains that dirt is beneficial in concrete and makes it flow easier, the carpenter who drops the shavings in the column forms, the laborer who steps on the reinforcement, and the carpenter foreman who knocks the shoring out because he needs it on the next story; if he can do that he will have accomplished something worth while and we may begin to reform our formulas afterwards.

Alexis Saurbrey.

New England Bldg., Cleveland, O., May 20, 1910.

[Mr. Godfrey's reply to the above is printed below.—Ed.]

Sir: I have before me Mr. Alexis Saurbrey's letter commenting on my reply to his criticism of the paper, "Some Mooted Questions in Reinforced-Concrete Design," recently read before the American Society of Civil Engineers. I beg to thank you for the opportunity to reply.

A number of Mr. Saurbrey's comments can be answered by this: A reinforced-concrete beam can be considered as a plain concrete beam up to the point of what would cause failure by tension in the concrete. It is not necessary, however, that this be rigidly observed, for the tension steel will undoubtedly aid the concrete before the latter cracks. The ultimate tensile strength of good concrete is not far from the safe compressive strength. Hence this assumption is a good working basis. Tensile strength in concrete is a reality and has to be dealt with. This does not mean that it can be depended upon as a direct element in the strength, but that it has its effect in deflection, and it has a real influence in locating the neutral axis and in preserving the integrity of reinforced concrete. Keeping this assumption in mind it serves to answer M. Saurbrey's points as follows:

(1) The neutral axis in this plain concrete beam will be close to the middle of the concrete beam. The theory given by Mr. Saurbrey might locate the neutral axis in a cracked beam, if the modulus of elasticity were a constant and known quantity instead of a variable.

(3) I have not denied the practicability of constructing I-beams, but have tried to show that a lot of analysis goes to waste because the analyst fails to see that the T-beam needs more width in the stem than merely enough to put the steel in. The horizontal shear must be taken into the rods and the steel must be gripped. These require a width of beam that makes guesses as to the width of slab that may be included in the T of little value, because the stem of the T will usually be nearly if not quite wide enough for a rectangular beam. In such a beam the neutral axis will be close to the middle of the depth of the concrete, and simplification of the formula results.

(5) The designer who accepts the assumption with which I started out has nothing to do with a cracked beam in safe design, for the beam need not crack, except possibly from shrinkage. He need not anticipate that his beam will be composed of segments cracked away from one another with the ever-present possibility of the indefinite multiplication of these cracks. If it be accepted that cracks must occur in a beam designed properly and with moderate calculated stress in the steel, there is no limit to the number of these cracks; for if they must occur at one point, the same law would dictate that they may occur at another. It is no doubt true that an elongation in concrete equal to that in steel when the latter is stressed to 16,000 lbs. or less means cracked concrete, but this is beside the question. A properly designed reinforced concrete beam will be designed with concrete enough to grip and protect the steel, and this concrete will help out the steel to prevent cracks. If shrinkage cracks do occur, the steel must, of course, be abundantly able to take the stress. Tension rods will stretch and take stress with the concrete as the beam deflects, but the vertical stretch in a beam beside a stirrup is microscopic.

Turning now to Mr. Saurbrey's other points. I do not assert that every building not designed in conformity with the principles laid down in my paper is on the verge of collapse, but merely that tests with the working load, the tests of service, prove nothing, since such tests may be repeatedly made and yet failure may eventually take place.

As to the necessity of building a masonry arch hinge-ended because it happened to be calculated as a row of blocks: It is a shame that the thick haunches of an arch must be made to perform no office, merely to carry out a designer's assumption. This was done with disastrous results in two arches built some years ago in Europe. The arch ring, which was thick at the springing, was throttled down to a little greased bearing block, so as to realize the designer's stresses. Instead of a safe structure there was collapse and great loss of material and work. There are entirely too many uncertainties about a masonry arch, such as settlement and rotation of foundation. The designer cannot afford to trifle with such structures by neglecting important elements of strength. By the method of calculating a concrete arch given in my book "Concrete" there is a large bending moment close to the springing, even in an arch calculated as hinged-ended. Anchoring the reinforcing rods into the abutment is recommended, as well as top and bottom reinforcement throughout the arch ring.

Mr. Saurbrey by quoting part of what I say in two cases conveys a wrong impression. Where I say, "How can concrete, even if it were in compression, perform this office?" the "office" referred to is not gripping a U-bar but the office that an iron vice could not perform, namely, to hold the bar for its full strength by pinching a few inches of the end of the bar. The middle quotation of three near the end of his letter is the last part of a sentence, the first part of which refers specifically to "hoops which are not close enough to stiffen the rods." Columns so designed might be called hooped columns, but they are not strong.

Under (6) Mr. Saurbrey goes further into shear. My assertion was merely that we know what is meant by the shear in a vertical section of a beam. Mr. Saurbrey in denying this goes into a different matter entirely, namely, the way to provide for this shear in a beam, or rather the way the shear is taken by the concrete.

Mr. Saurbrey asks if my suggestion of nuts and a washer for anchorage is a joke, and asks why the rods cannot run into the next beam for anchorage. Of course they can run into the next beam, where there is a next beam; but in end beams and in isolated beams this cannot be done, and it is in such cases that a positive anchorage in a short distance is needed.

Edward Godfrey.

Monongahela Bank Building, Pittsburg, Pa., June 8, 1910.

[This final exchange of comments throws sufficient light on the points at issue, we believe, to close the discussion. From what has gone before, it will be clear, however, that in spite of the increasing uniformity of specifications and design regulations there are still many points about reinforced-concrete work on which broad differences of opinion are possible.—Ed.]

Notes and Queries.

In the article on smoke inspection at Milwaukee, in our issue of June 30, the name of the Smoke Inspector was given as Charles Poetsch instead of Charles Poethke.

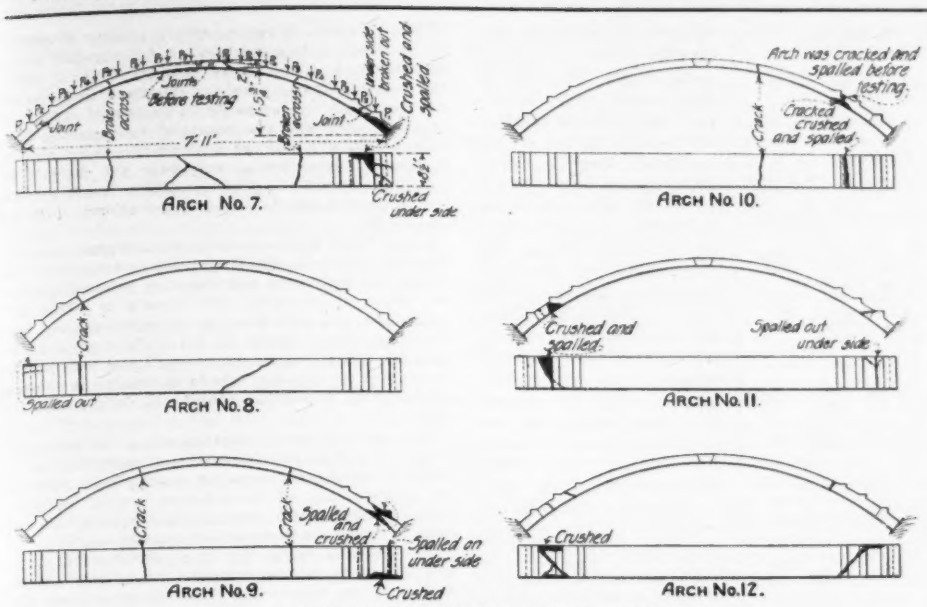


FIG. 1. MEDINA ARCH MODEL TESTS, SECOND SERIES.

(Diagrams showing Kind of Failure.)

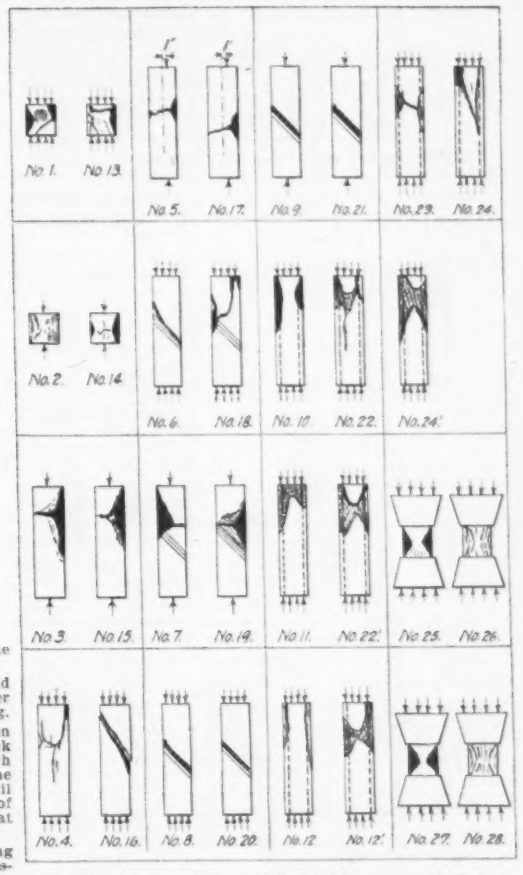


Fig. 2. Compression Failure Diagrams of Cubes and Prisms.

(Auxiliary to second series of Medina arch model tests.)

DETAIL DESCRIPTION OF ARCH TESTS.

ARCH NO. 7 was so loaded that the line of pressure through the rib was near the axis. While the levers were being placed on this arch, a load was accidentally applied to one of them, causing the rib to shear along one of the crown joints and producing a "fault" of about 1/16-in.; a crack was also opened in the right haunch. However, when tested it failed by crushing at the springing.

ARCH NO. 8 was loaded so that the line of pressure was near the upper edge of the middle third at the crown, and near the axis throughout the remainder of the rib. This arch was twice very heavily loaded. The first time the load applied was so great that the I-beam of the testing apparatus buckled and allowed the levers to deflect so much that their ratio became affected. However, the loads were left on for over an hour and during all of this time certain portions of the arch were stressed more than 5,000 lbs. per sq. in. Additional bracing was made for the apparatus and the arch was retested. In this test, after the stress had reached about 5,800 lbs., the I-beam again gave way and the arch was twisted sidewise and collapsed. Up to the time the I-beam twisted no signs of failure were apparent in the arch.

ARCH NO. 9 was loaded similarly to arch No. 7, and although the stress was theoretically slightly greater near the crown, it failed by crushing near the springing.

ARCH NO. 10 was twice knocked over and broken into pieces and then replaced. The contact in a crack in the right haunch was very poor, so that the arch began to spall and crumble at that point soon after the first loads were applied. This crumbling continued until the arch finally gave way at that point. This test is of little value, except that it is interesting to note how great a stress an arch will take even after being so abused.

ARCH NO. 11 failed by revolving backwards, showing that the needles may have become inclined, thus causing a sidewise horizontal thrust. The concrete of this arch and of arch No. 12 apparently was not very good. The proportion of cement was not large enough to thoroughly fill the voids. No cubes were made of this material, so that it was not possible to make a comparison of the strength of this material in cube form.

ARCH NO. 12 failed by crushing near the springing. The failure was comparatively slow.

It was "corrected" by mistake as the paper was going to press through confusing the Smoke Inspector (Mr. Charles Poethke) with the City Engineer (Mr. Charles J. Poetsch).

Second Series of Concrete Model-Arch Tests for Medina Aqueduct, New York State Barge Canal.

The first half of the notable model-arch tests arranged by the State Engineer of New York State for guidance in the design of the Medina gorge crossing of the Barge Canal—a 285-ft. concrete arch span—was described in our issue of March 10, 1910. Last month the second series of tests was carried out. Through the courtesy of State Engineer Frank M. Williams, we are now able to give the results of these tests also, from advance sheets of the "Barge Canal Bulletin."

The primary purpose of the second series, covering six arches, was to extend the data of the first series into the range of very heavy loading and high stresses. The influence of different distributions of stress was also to be studied, and in this point lies one of the striking features of the results: *All arches failed at the springing*, in spite of the fact that the loading was so distributed (at least in some of the tests) as to give the crown theoretically an extreme-fiber stress more than two times the unit-compression at skewbacks. In other words, failure did not occur at the point of highest computed stress but at a point where, theoretically, the stress was only about half as great as the maximum.

TEST MATERIAL.—The six arches of this series, numbered 7 to 12, are of the same shape and size as the first six (see reference above), and like these were cast in sections with short key-pieces at crown and springing. They included three different mixtures:

2 arches of 1:2 mortar.
2 arches of 1:2:4 gravel-concrete.
2 arches of 1:2:4 limestone-concrete.

They were tested at ages 27 to 38 days.

It was observed that the bond between main sections and keys was very weak. The arches were easily knocked out of line, and three of them were disturbed or broken and put together again before test. (See also report for Arch No. 7, under Table I.)

The second arch tested, No. 8, carried such a heavy load (over 40 tons), that the 20-in. I-beam forming part of the testing apparatus buckled sidewise, which broke the arch. For the last four arches the 20-in. I-beam was therefore braced horizontally by a light truss fastened to its bottom (compression) flange.

Cubes 6 × 6 × 6 ins. and prisms 6 × 6 × 36 ins. were tested in compression, auxiliary to the arch tests. These are noted below.

RESULTS OF ARCH TESTS.—Table I states the results of the six tests; notes on the behavior of the individual arches are given below the table. Deflections were measured at crown and haunches, but these are not included in the table.

The computed stresses are based on the assumption that the stresses over a section are distributed according to a straight-line law. All arch stresses were calculated by the formulas of Turneaure and Maurer, which assume a constant modulus of elasticity. It was recognized by those in charge that the actual stresses existing at failure would not be represented satisfactorily by the values from the formulas, but the calculation values are nevertheless instructive.

All six arches of this series, as well as those of the first series, *failed near the springing*, although in most cases the theoretical maximum stresses occurred at the crown. For Nos. 8 and 12 the loading was purposely made such that the theoretical extreme-fiber stress at crown was very much greater than at any other point; nevertheless they failed by crushing near the springing.

In the first series, the prism tests indicated that, when the load was applied at the edge of the middle third (giving on the straight-line assumption a maximum fiber stress of twice the average), the apparent ultimate strength of the

TABLE I.—TESTS OF CONCRETE MODEL ARCHES, MEDINA AQUEDUCT, NEW YORK STATE BARGE CANAL; SECOND SERIES.

(Arches, 7 ft. 11 ins. clear span; Crown thickness, 2 ins. Tested at Albany, N. Y., May, 1910.)

(NOTE: For Arch No. 9, the "Maximum Stresses in Pounds per Square Inch" should be given a minus sign.

Arch Number	Composition and material.	Age, days.	ITEMS.	Loads, in Pounds. P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	Total load on arch in pounds.	Load on arch in pounds per sq. ft.	Maximum Stresses, in Pounds Per Square Inch. Top.	Bottom.	Top.	Bottom.	Compressive strength of 6-in. cubes in lbs. per sq. in.
			Loads exerted on arch by weight of arch, plates, levers, etc.	256	240	225	217	211	207	204	203							
7	1-Portland cement; 2-Albany sand	27	Weight on levers at failure	80	85	76	73	73	63	60	59	60,020	10,700	c—3,032	a—1,262	b—1,195	b—2,900	2,330
			Total load on arch	4,256	4,490	4,025	3,867	3,861	3,267	3,164	2,803							
8	1-Portland cement; 2-Albany sand	34	Weight on levers at failure	128	128	102	91	82	56	53	101	80,626	14,380	c—5,053	c+ 86	d—2,314	b—2,974	1,730
			Total load on arch	6,656	6,640	5,325	4,767	4,311	3,007	3,164	5,252							
9	1-Portland cement; 2-Niagara river sand; 4–1½ in. river gravel	32	Weight on levers at failure	86	93	84	80	80	69	69	57	65,536	11,700	a3,297	a1,493	b1,396	b3,176	2,160
			Total load on arch	4,656	4,860	4,425	4,217	4,211	3,657	3,654	3,053							
10	1-Portland cement; 2-Palmyra sand; 4–1½ in. Palmyra gravel	31	Weight on levers at failure	56	56	54	51	51	44	37	31	41,526	7,430	a—2,121	a—915	b—674	b—2,117	1,920
			Total load on arch	3,056	3,040	2,925	2,767	2,761	2,407	2,054	1,753							
11	1-Portland cement; 2-Albany sand; 4–1½ in. limestone	22	Weight on levers at failure	64	56	54	59	51	44	44	36	44,226	7,880	c—2,249	c—983	b—821	b—2,162	
			Total load on arch	3,456	3,040	2,925	3,117	2,764	2,407	2,404	2,003							
12	1-Portland cement; 2-Albany sand; 4–1½ in. limestone	38	Weight on levers at failure	72	72	57	51	46	24	46	60	47,326	9,450	c—3,530	c+ 57	d—1,546	d—1,596	
			Total load on arch	3,856	3,840	3,075	2,767	2,511	1,307	2,504	3,303							

* Broken and badly injured before testing.
a At P_7. b Between P_7 and P_8. c At crown. d At springing. e At P_1.

TABLE II.—CUBE AND PRISM TESTS OF CONCRETE ACCOMPANYING SECOND SERIES OF MODEL-ARCH TESTS.

Prisms, 6 × 6 × 36 ins.
Cubes, 6 × 6 × 6 ins.
Composition: 1 part American Portland cement.
2 parts Troy sand.
4 parts ¾-in. limestone.
Age, about 21 days.
Tested at Rensselaer Polytechnic Institute, Troy, N. Y., March, 1910.

NOTE: In the second column, "2nd batch," the sixth figure from bottom should read 22' instead of 22.

Specimen Number. 1st batch.	Specimen Number. 2nd batch.	Size.	Description.	How loaded.	Load at incipient failure.	Load at ultimate failure.	Stress per sq. in. at ultimate failure.	Average stress at ultimate failure.
1		6" x 6" x 6"		Uniformly	76,400	110,500	3,069	3,326
	13	Do.		do.	129,000	129,000	3,583	
2		Do.		Concentrated centrally	97,500	100,000	2,777	2,762
	14	Do.		do.	96,000	98,925	2,747	
3		6 x "6" x 36"	Plain sides	do.	79,900	79,900	2,221	2 171
	15	Do.	do.	do.	76,380	76,380	2,121	
4		Do.	do.	Uniformly	70,000	74,500	2,069	2,178
	16	Do.	do.	do.	82,360	82,360	2,287	
5		Do.	do.	Eccentrically, 1"	53,460	53,460	2,970	2,852
	17	Do.	do.	do.	49,220	49,220	2,734	
6		Do.	Sides grooved 1" deep at 45°	Uniformly	72,640	72,640	2,512	2,196
	18	Do.		do.	67,700	67,700	1,880	
7		Do.	do.	Concentrated centrally	69,760	69,760	2,414	2,197
	19	Do.	do.	do.	71,340	71,340	1,981	
8		Do.	Sides grooved 2" deep at 45°	Uniformly	44,290	44,290	1,942	1,887
	20	Do.		do.	41,510	41,510	1,832	
9		Do.	do.	Concentrated centrally	40,090	40,090	1,765	1,945
	21	Do.	do.	do.	48,240	48,240	2,126	
10		Do.	Reinforced with 4 ½-in. square bars of low elastic limit.	Uniformly	80,730	80,730	2,242	2,458
	22	Do.		do.	88,740	88,740	2,465	
11		Do.		do.	83,130	83,130	2,309	
	22	Do.		do.	101,300	101,300	2,816	
12		Do.	Reinforced with 4 ½-in. square bars of high elastic limit.	Uniformly	85,670	85,670	2,379	2,491
	23	Do.		do.	97,420	97,420	2,706	
12'		Do.		do.	83,820	83,820	2,328	
	24	Do.		do.	78,400	78,400	2,178	
24'		Do.		do.	103,150	103,150	2,864	
25		6" x 6" x 6"		Uniformly between concrete blocks.	107,560	114,000	3,167	2,908
	26	Do.			85,000	99,700	2,709	
27		Do.		do.	87,500	112,490	3,125	2,940
	28	Do.		do.	90,600	99,200	2,755	

extreme fiber was 34% greater than the strength of the concrete when uniformly stressed. In the present series the corresponding figure was 31% excess. But in the arch tests Nos. 8 and 12 the theoretical extreme-fibre stress at crown, where middle-third loading was supposed to exist, was *more than* 125% *greater* than the computed stress at the springing, where the stress was supposed to be uniformly distributed.

The conclusions drawn from the results of this series of tests are as follows:

(1) That material in an arch when the line of pressure follows the axis, will take at least as high a stress as the same material in cube form uniformly stressed.

(2) That the allowable working-stress in bending in an arch may safely be much greater than the allowable unit-stress for columns.

(3) That an arch of theoretically uniform strength throughout will fail at the springing, and that the working-stress for the springing should be smaller than that for the crown, perhaps at least 25% smaller.

(4) That the allowable working-stress on the extreme fiber, when the line of pressure passes through the edge of the middle third, may be 30% higher than the corresponding stress when the line of pressure coincides with the axis.

Cube and Prism Tests in Second Series.

Table II. summarizes the cube and prism tests of this series. As in the arch computations the calculated stresses assume a straight-line distribution of stress over the section.

The manner of failure of the cubes and 22 prisms of the series is sketched in Fig. 2.

As the arches of the previous series withstood a much higher stress than any of the cubes, it was decided to apply the load to the cubes in different ways, in order to obtain additional information. The loads were applied in three ways: (1) Uniformly over the whole surface; (2) concentrated on a single line by the knife edge; (3) uniformly between concrete blocks. The loads to the prisms were applied in two ways—by concentrated load and by uniform load. The manner of application did not seem to affect the results.

In order to study further the shear in prisms, a number of specimens were cast with grooves, similar to the specimens of the first series, on opposite faces of the specimens, some 1-in. and some 2 ins. deep, at an angle of 45° with the vertical axis. Most of these specimens failed by splitting through their center, on a plane parallel to the grooved faces; none of either series failed by shearing along the reduced section. The load component parallel to the groove, producing shear at bottom of groove, represented an average shear, in the four specimens, of 1,819 lbs. per sq. in. Yet there was no shearing failure under this high stress. The stresses given in the table are for the point at which the failure apparently occurred.

One of the normal prisms, however, apparently failed by shear. This was the only prism of either series, either grooved or plain, which failed by apparent shear on a diagonal plane.

The few reinforced prisms tested were not thought to yield any useful conclusions.

CONCLUSIONS. — The conclusions drawn from the second series of tests on cubes and prisms are:

(1) The highest resistance is obtained from cubes uniformly loaded.

(2) The apparent ultimate resistance of the most heavily loaded fiber is 31% greater for prisms having an eccentricity of 1 in. (center of pressure acting at edge of middle third) than for prisms centrally loaded. (This conclusion is based on assumed straight-line distribution of stress.)

(3) Failure of prisms by shear in advance of failure by direct compression is not to be expected.

Conservation of Water-Powers.*

By LEWIS B. STILLWELL.†

The conference of governors, which assembled at the White House, in May, 1908, in response to an invitation extended by President Roosevelt, focused the attention of the American people upon a subject which all recognize as one of fundamental national importance and one which appeals to the engineering profession with all the force which comes from special knowledge. True conservation of our natural resources means wise utilization of those resources without unnecessary waste. Such utilization of materials used in construction and of energy is the primary and essential business of the engineer. Since the days of Smeaton and of Watt, the engineer has been building the lighthouses of material prosperity and releasing and directing for the common welfare those vast forces of nature imprisoned and overlooked for centuries but now utilized on a scale which dwarfs the physical powers of man to insignificance.

During the last 25 years, a period practically conterminus with the life of this institute to date, the art of transmitting power by electricity has grown from a laboratory experiment into a development universally recognized as one of the great factors of industrial and commercial life.

The latest publication of the U. S. Geological Survey, relative to this subject, estimates the aggregate water-powers of the United States at minimum flow to be 36,000,000 HP. and the aggregate which presumably can be developed on the basis of six months' flow per annum at not less than 67,000,000 HP.

A very large proportion of the water-powers hitherto unappropriated are either located upon government lands or are dependent, wholly or in part, upon the run-off from government lands.

The regulations established by national and state governments which control or affect the further utilization of water-powers, therefore, are of peculiar concern to the members of this institute. A bill endorsed by the administration is now before Congress which, if passed, will confer definitely upon the President and his executive assistants full authority in respect of withdrawal of public lands and unappropriated water-powers. Probably the bill will pass and if so we may expect that the question of governmental machinery and methods for handling practically this highly complex and vitally important subject will be raised in acute form. [The bill passed.—Ed.]

If the views of the engineering profession are to be effective, either in moulding public opinion or in assisting the legislative and executive representatives of our people, by supplying facts essential to correct generalizations and deductions, it is important that the views be clearly stated at the right time and the apparent lack of agreement among those best qualified to measure the practical results of existing or proposed governmental regulations should not destroy their influence.

The present occasion seems opportune for the presentation of a brief and non-technical discussion of the practical bearing and effect of existing laws governing the appropriation of water-powers located on public lands, which, as now construed and applied, are seriously retarding the utilization of these powers.

To those who realize the vast possibilities of a far-sighted and thoroughly scientific development and utilization of our water-power resources, particularly those of the Rocky Mountains and the Sierras, no subject can be more interesting. Present practice, whether ideal or faulty, is more likely to be modified than revolutionized, and now is the time for unprejudiced and candid discussion of the regulations now in force.

The Relation of Forests and Stream Flow.

The Bureau of Forestry has established regulations governing the appropriation of water-powers located on streams which drain watersheds included in whole or in part in Forest Reserves. Among these regulations is the imposition of a graduated rental, to be paid by the individual or corporation appropriating the water-power and used by the Government for forest purposes. This rental rests upon the assumption that the appropriator of the power will be benefited by the preservation of the forest, and this idea is accepted generally by engineers and by the public.

Mr. Gifford Pinchot, Chief Forester at the time when the present regulations were established, states his understanding of the physical facts upon which this charge is based in a document explaining the policy of the Forest Service, as follows:

The National Forests include the great mountain chains of the West. The rain and melting snow of these ranges feed the mountain streams. The forest cover on the steep slopes acts like a mighty sponge, absorbing the excess of rainfall in the wet season and giving it out to the thirsty lands in the dry season. It is for the express purpose of thus "securing favorable conditions of water flows" (Acts June 4, 1897) that Congress has authorized the creation of national forests and expends money for their administration and maintenance. Where the forest cover is destroyed by reckless lumbering and the fires which inevitably follow, the rains immediately run off the steep slopes as from the roof of a house, producing destructive floods in the valleys and leaving no store of water for the dry season. Therefore, when a power company puts its plant on national forest land, it gets from the Government two things which it ought to pay for, viz., (a) the use of lands of great value for power purposes, for the steep mountain sides give the fall which is essential for a power plant; (b) the guarantee of a steady flow of water as an incident to the land occupied by the plant. This steady flow is also essential to a power plant.

During the last two years, the question of the actual or assumed effect of forests on the watershed in regulating the run-off, has been widely debated. That forest cover controls the run-off to a material extent has been vigorously asserted by engineers prominent in the government service and by many others, and on the other hand, it has been seriously questioned by a number of our leading engineers, notably by Col. Chittenden, in a paper read before the American Society of Civil Engineers, in March, 1909, and by Dr. Willis L. Moore, Chief of the U. S. Weather Bureau, in a report addressed to the Committee on Agriculture, of the House of Representatives, in 1910, entitled "A Report on the Influence of Forests on Climate and on Floods." [Eng. News, March 3, 1910.—Ed.]

I do not propose to enter into a detailed discussion of this complex subject at this time. Col. Chittenden's paper and its discussion have covered the subject perhaps substantially as well as it can be covered by applying the inductive method to existing records.

The report of Dr. Moore and the article on "Floods," in Water Supply Paper No. 234, prepared by the U. S. Geological Survey, also debated the subject at great length, the radical difference of opinion between these two gentlemen being due apparently in large degree, to the fact that Dr. Moore is considering total annual run-off, while Mr. Leighton is investigating the relation of "flood tendency" to precipitation.

As Dr. George F. Swain pointed out in a recent discussion of this subject at Boston, [Eng. News, April 14,

*Presidential address at the Annual Convention of the American Institute of Electrical Engineers, Jefferson, N. H., June 28-July 1, 1910.

†Consulting Engineer, 100 Broadway, New York City.

1910—Ed.] the difficulty in reaching an agreement along the lines adopted in the papers referred to results from the fact that all of these gentlemen are applying the inductive method of reasoning to a subject so complex and so varied as practically to preclude the possibility of general agreement in the inferences drawn. The physical laws which govern the phenomena under discussion are all well known, and to the scientist the deductive method of dealing with this subject is not only easier but is more convincing than the attempt to draw conclusions from incomplete records of precipitation and stream flow where even approximate knowledge of the extent to which the surface of the watershed in question is forested, or plowed, or covered by vegetation other than forest, is not available.

Such reasoning unquestionably leads to the conclusion that the preservation of forests on the watershed does to a greater or less extent regulate and control, not the aggregate annual run-off, but the rate at which that run-off varies during the year, and this idea is accepted generally by engineers and by the public. It is also accepted apparently by the majority of engineers who have discussed this subject in our various engineering publications, using the inductive method in drawing their conclusions.

As the essential physical facts which bear directly upon forest control of run-off, and consequently upon the relation of forested watersheds and water-power, the following as stated by Dr. Moore may be accepted probably without material error:

(1) Precipitation controls forestation, but forestation has little or no effect upon precipitation.
(2) Any local modification of temperature and humidity caused by the presence or absence of forest covering, the buildings of villages and cities, etc., could not extend upward more than a few hundred feet, and in this stratum of air saturation rarely occurs, even during rainfall, whereas precipitation is the result of conditions that exist at such altitudes as not to be controlled or affected by the small thermal irregularities of the surface air.
(3) During the period of accurate observations, the total annual precipitation has not increased or decreased to an extent worthy of consideration.
(4) The total annual run-off of our rivers is not affected materially by any other factor than precipitation.
(5) There is no adequate evidence to justify the conclusion that extreme floods in recent years attain higher stages than formerly.

Other conclusions stated by Dr. Moore in the report above referred to the author is not prepared to accept, and as regards that forest control which is practically related to the commercial value of water-powers, he believes the following to be a correct statement:

While the aggregate annual run-off of our rivers in general depends upon the total annual precipitation, the presence of forest cover on the watershed regulates the rate of run-off to an extent which in many cases materially affects the value of the water-power, this regulation tending to equalize the flow and prolong it during the dry season.

With this understanding of the essential physical facts which are pertinent it is proposed in this paper (1) to discuss briefly certain provisions included in the present regulations of the Forest Service governing the appropriation of water-powers dependent in whole or in part upon forest reserves, and (2) to suggest the outline of a plan which to the author appears preferable to that now in force.

The present form of permit provides a nominal charge (rental) for the land occupied by power-house, dam, canals, penstocks, flumes, etc., the rate being "$1 per acre and $5 per mile for the land occupied by said works." It provides also that

the gross operation charge for any year shall be calculated by the forester upon the basis of the quantity of electric energy generated in such year at a maximum rate, which shall not exceed the following amounts per 1,000 KW-hrs.:

For the	1st	year				2 cts.
"	2nd	"				4 "
"	3rd	"				6 "
"	4th	"				8 "
"	5th	"				10½ "
"	6th	to	10th	years,	incl.	12½ "
"	11th	"	15th	"	"	15 "
"	16th	"	20th	"	"	17½ "
"	21st	"	25th	"	"	20 "
"	26th	"	30th	"	"	22½ "
"	31st	"	35th	"	"	25 "
"	36th	"	40th	"	"	27½ "
"	41st	"	45th	"	"	30 "
"	46th	"	50th	"	"	32½ "

The foregoing are maximum rates applicable only in cases where all the water utilized comes from the Forest Reserve and the entire head developed results from the topography of the forest: In all other cases, deductions are made as follows:

From the gross operation charge for any year calculated as above:
(a) A sum bearing approximately the same ratio to one-half of such gross operation charge as the area of unreserved land on the watershed bears to the total area of the watershed as of the beginning of each year.
(b) A sum bearing approximately the same ratio to one-half of such gross operation charge as the length of conduit outside the Forest Reserve bears to the total length of such conduit as of the beginning of each year.
(c) A sum bearing approximately the same ratio to the balance remaining after said deductions "a" and "b" as the quantity of electric energy generated from water stored artificially by the permittee over and above what is generated by the natural flow, bears to all electric energy generated.

The sum remaining after all the aforesaid deductions have been made constitutes the net operation charge for such year.

The rationale of the deduction for water stored artificially by the permittee is obvious. That for the first two deductions described is stated in an informal explanatory document of the Forest Service, as follows:

Since the two advantages furnished by the Government are the maintenance of a steady flow from the forested watershed, and the fall resulting from the topography of the forest, one-half of the conservation charge is calculated as based upon each of these advantages. Therefore: (a) If a part of the watershed which supplies the power plant is outside of the national forest, the one-half of the conservation charge calculated upon the advantage resulting from the maintenance of the steady flow by the conservation of the forest cover is reduced proportionately, and (b) if a part of the fall which the permittee is to use in developing power is outside of the national forest, the one-half of the charge which is based upon the fall is reduced proportionately.

The Imposed Rates as a Tax on Power Enterprises.

The proposed conservation charge, at least during the early years of the contract, cannot be regarded reasonably as constituting any very serious financial burden imposed upon the individual or corporation developing the water-power. If power be sold at an average price of 1 ct. per KW.-hr., the maximum conservation charge during the first five years of operation is equivalent to a tax of 0.61% of gross receipts. During the next five-year period, it is increased to 1.23% of gross receipts and it increases gradually from this figure to a maximum of 3.25% of gross receipts, which rate applies during the last five year of the 50-year life of the contract. The average charge during the 50-year period is 2.086% of gross receipts, if power be sold at the price assumed, viz., 1 ct. per KW.-hr.

If power be sold at an average price of 0.5-ct. per KW.-hr. the average conservation charge during the period of the lease becomes 4.172% of gross receipts, and the maximum, which applies during the last five years of the lease, is 6.5% of gross receipts.

It is a fair question, however, whether a more rational method, and one which in certain important respects would tend to produce better results, might not be devised. The plan in force obviously is open to several objections. Among these are:

(1) The imposition of a tax upon output means that the man who installs a highly efficient plant is called upon to pay a higher conservation charge than the man who wastes water by the installation of a cheap and inefficient plant. The effect of the conservation charge in influencing type of construction, and consequent effective utilization of the water, will probably be small but unquestionably that influence is exerted in the wrong direction.

(2) The proposed method of charging imposes a heavier burden upon the man who sells his power at a low price than upon him who sells it at a high price. The tax, measured in percentage of gross receipts, is obviously twice as high in the case of the man who sells power at an average price of 0.5-ct per KW.-hr. as it is in the case of a man who sells power at an average price of 1 ct. per KW.-hr.

Both of these objections were pointed out in a paper read by Mr. F. G. Baum, before the American Institute of Electrical Engineers, at Atlantic City, N. J., in 1908, but the writer has not heard them referred to since, and they deserve careful consideration.

(3) Mr. Baum also calls attention to the fact that under the plan proposed by the Forest Service

the man who takes his power to a market, say one hundred to three hundred miles away, must pay to the Government for the losses incurred in doing so and pays more than the man who sells to the home market. The man who reaches out with his power is equalizing conditions, just as railroads equalize conditions by their transportation facilities.

The Italian law, recognizing this point, reduces the rental in the case of transmitted power. The basis of this reduction, as stated by M. Rene Tavernier, Chief Engineer, Department of Public Works, Republic of France, in his valuable article on "The Public Utility of Water Powers and their Government Regulation" (Water Supply Paper No. 238) is as follows:

For power transmitted by means of electricity to distances greater than 10 kilos (about 8 miles) there is granted upon the annual rental of 3 francs per horsepower, a reduction calculated by multiplying the square of the distance expressed in kilometers by a fixed coefficient of 0.001. In no case shall the rental be reduced to less than one-half of 1 franc per horsepower.
Under this formula the minimum reduction, that is to 0.50 franc, will be attained in transmission over 50 kilometers (about 31 miles).

While the method of applying the "conservation charge" has been criticized in many quarters and while the objections above pointed out are valid, the method in force possesses undoubted advantage in the fact that it is definite and readily determined by reference to records which the permittee can easily keep. The charges moreover are adjusted to encourage development of the water-powers by recognizing the fact that few, if any, can earn interest on the necessary investment from the start. In enterprises of this kind, the cost per unit of output generally decreases as the output increases. The forest service charge, recognizing this fact, is made small at the start and increases gradually. Except by reducing the average charge for the period, it would be difficult to devise a plan less onerous for the permittee.

(4) While the imposed charge could not be regarded as excessive, if the power developed were entirely, or even largely, dependent upon the preservation of forest cover upon the watershed, it represents a high rate when measured in comparison with the increase in commercial value of the power, which, under ordinary conditions, is due to the forest. If for illustration, it be assumed that under average conditions "forest control" adds 25% to the value of the water-power, a tax averaging 4.172% of gross receipts is a tax of 20.80% of the gross value contributed by the forest.

(5) The tax is imposed upon power from all "forest reserve lands," regardless of the actual condition of the forest upon which it is based. Obviously, therefore, a uniform tax must be very much heavier in some cases than in others, as compared with the benefit upon which it theoretically rests.

(6) It tends to retard utilization of water-powers and stimulates the use of coal for power purposes—a result which is in direct contravention of the primary object of conservation.

(7) Something less than one-half the public domain is included within the limits of the forest reserves. To secure maximum revenue and to minimize the average retarding effect upon utilization of these water-powers resulting from a system of rental, any charges which may be imposed by the Federal Government upon water-power appropriation should apply to all public lands.

The author has expressed the opinion that the imposed charge would not be regarded as excessive if the power developed were entirely, or even very largely, dependent upon the preservation of forest cover upon the watershed. In his judgment, however, that effect has been very greatly exaggerated by the majority of writers who have endeavored to instruct the public regarding the subject.

To sustain the announced theory of the Forest Service, it is evident that the value of the water-power should be directly dependent upon forest control of the run-off. Obviously the statement that "the forest cover on the steep slopes acts like a giant sponge, absorbing the excess of rainfall in the wet season and giving it out to the thirsty lands in the dry season" and that the "power company which puts its plant on national forest land gets from the Government the guarantee of a steady flow of water" are highly figurative.

The extent to which forest cover and other surface conditions which tend to regulate run-off, succeed in equalizing stream flow, is illustrated in the accompanying tabulated statement, showing in the case of ten fairly representative rivers of the Atlantic and Pacific slopes the maximum, average and minimum run-off in second-feet per square mile for periods of five consecutive years and the minimum run-off expressed (a) in percentage of maximum run-off and (b) in percentage of average run-off.

Without attempting to discuss the complex conditions which determine the relations of maximum, average and minimum run-off, it is evident that in no case does existing forest cover or any other surface condition effectively equalize the flow.

As regards the relation of minimum to maximum run-off, the most favorable case, that of the Merrimac River, shows a minimum flow of 1.86% of the maximum, while for the ten rivers the minimum flow averaged is 0.837% of the maximum flow averaged. As regards the relation of minimum to average run-off, the most

FIVE-YEAR RUN-OFF TABLE; TEN AMERICAN RIVERS.

River.	Gaging station.	Drainage area sq. miles.	Maximum run-off, sec.-ft. per sq. mile.	Average run-off, sec-ft. per sq. mile.	Minimum run-off, sec.-ft. per sq. mile.	Minimum in per cent. of Max.	Minimum in per cent. of Ave.
Kennebec	Waterville, Me.	4,380	17.5	1.96	0.0388	0.222	1.98
Merrimac	Franklin Junction, N. H.	1,460	16.93	1.998	0.315	1.86	15.77
Connecticut	Holyoke, Mass.	8,144	14.12	1.623	0.258	1.83	15.9
Susquehanna	Binghamton, N. Y.	2,400	19.62	2.044	0.0187	0.095	0.916
Yadkin	Wilkesboro, N. C.	500	36.8	2.446	0.43	1.17	17.6
Savannah	Augusta, Ga.	7,294	18.83	1.56	0.198	1.05	12.7
Black Warrior	Near Cordova, Ala.	1,900	26.0	1.515	0.01473	0.0567	9.73
Feather	Oroville, Cal.	3,640	29.0	2.354	0.33	1.14	14.0
Yakima	Near Yakima, Wash.	3,300	19.37	1.322	0.1926	0.995	14.56
Naches	Near North Yakima, Wash.	1,120	19.55	1.489	0.0268	0.137	1.8
			21.772	1.8311	0.18226	0.837	9.95

favorable case, the Yadkin, shows 17.0% while the average of the ten rivers is 9.95%.

The effect of forest cover in adding to the commercial value of a water-power, results from two facts, namely, first, the fact that an increase in minimum run-off reduces the necessary investment in auxiliary steam or other power plant; second, the fact that some portion of the flood waters, which otherwise would flow past the power plant, at a time when the water available exceeds the amount needed, is held back long enough to permit its commercial utilization. As regards the first of the two conditions referred to, if we assume that auxiliary steam-power is used to insure a continuous supply equal to the average which a given head on each of these rivers can develop, it will be seen that such auxiliary plants must be capable of producing power in an amount ranging from 82% to 98% of the water power. The difference, therefore, between the best and the worst case among these typical streams affects the cost of the auxiliary plant to the extent of 16% of the cost of a steam plant capable of developing the same output as the water power.

As regards the effect of forest cover upon the relative proportions of energy output from the water-power and from the auxiliary steam plant, the conditions are so complex as to prevent profitable generalization. The holding back of a portion of the flood waters saves fuel and other operating costs of the auxiliary steam plant or reduces the artificial storage required. While it is evident that this effect, under the best conditions existing upon any of the watersheds, drained by the streams referred to in the table, is not such as to justify the theory that the forest is the principal factor affecting the value of the water-power, the author would not be justified, from present knowledge, in attempting to fix its average effect upon that value.

Features of the Present Regulations Which Should be Changed.

PERMIT NON-TRANSFERABLE (CLAUSE 15).—Clause 15 of the power agreement now in force reads as follows:

> The permit here applied for shall be non-transferable (U. S. Revised Statutes, Section 3737) and shall be subject to all prior valid claims which are not by law subject thereto.

The aim in view of course is to avoid monopoly, as a result of which an artificial price might be maintained higher than the average which would be fixed by competition of similar developments in the same market.

If effective, it is obvious that this requirement must retard development. The economic reasons which demand that water-powers on the same stream should deliver their output to the same network of distributing circuits in many cases are material, and those which demand that the output of developments on different streams should be similarly combined are even more weighty. In the former case, under certain conditions, as has been pointed out by Mr. W. S. Lee, in his paper before the American Institute of Electrical Engineers, (Proceedings for April, 1910), the net output of a stream effective for commercial purposes may be considerably increased. In the latter case, owing to the fact that the relative run-off of neighboring watersheds sometimes varies widely during successive years, the reliability of the supply of power to the user is materially increased by combination. To put the matter another way, if combination be not permitted the aggregate investment in auxiliary steam plants or gas-engine plants must be largely increased, which obviously is bad economy and means an increase in cost of power not only to the producer but also to the user.

By electrically combining the output of a considerable number of water-powers, interruptions of service, due to accidents to flumes, or to transmission circuits, are decreased.

The clause, in my judgment, should be modified by permitting transfer, subject to approval by the government. The right of a state or municipality to fix charges, in the case of a public utility company selling its product within the limits of such state or municipality, has been established by decisions of the Supreme Court of the United States. The danger that American communities in general, knowing this fact, will submit for any great length of time to the imposition of rates that are really extortionate, is not comparable to the economic loss which is certain to result from the imposition of conditions limiting the opportunity for profitable investment of capital. In this connection it is evident that even an assumed water-power monopoly of the largest conceivable size must sell its power at a cost lower than the cost of competing power produced by steam plants.

The established right of a state or municipality to fix rates at which power is sold is an absolute protection applicable by local governments best able to judge the conditions which determine what is an equitable charge.

CONTINUOUS OPERATION OF PLANT.—Clause 18 reads as follows:

> The permittee shall, except when prevented by the act of God or the public enemy, or by unavoidable accidents or contingencies, continuously operate for the generation of electric energy, the works to be constructed under the permit hereby applied for, in such manner as to generate after such generation begins, not less than the following percentages of the full hydraulic capacity of the said works measured in kilowatt hours in the first year . . . per cent; in the second year . . . per cent.; in the third year . . . per cent; in the fourth year . . . per cent.; in the fifth year . . . per cent.; and in every year hereafter . . . per cent.

The object in view is to prevent a power company increasing its prices by creating an artificial power famine and to secure full utilization of the available power. Some permits have specified that not less than 25% of the full hydraulic capacity, measured in kilowatt hours, must be generated; others as much as 75%, depending upon special circumstances supposed to govern the case.

In many cases this clause presents serious difficulty to the power company. In the majority of instances with which the writer has been personally familiar, it has been extremely difficult, if not impossible, to predict either maximum or minimum limits of the growth of power output. Circumstances may be conceived under which a power company, operating not only the plant covered by the permit but also other plants, might shut down the first named to produce temporarily an artificial scarcity of power, but the fact that this would mean an idle investment would make this a rare case. If it be necessary to retain such a clause, it should be accompanied by a provision permitting, with the consent of the government, a reduction in the percentages originally fixed.

While discretionary power to make conditions upon which capital has been invested more onerous will retard or prevent development, the bestowal upon a Secretary of Agriculture or a Secretary of the Interior, of power to make those conditions less onerous involves no corresponding public risk, since that Secretary would destroy himself politically who should grant such authorizations without proper cause. No power company can afford to invest capital under a contract which leaves it in the power of a government official to increase the burdens of the enterprise within the term covered by the permit, but the government and the public can well afford to bestow upon a responsible official authority to reduce those burdens upon proper application and presentation of valid reasons.

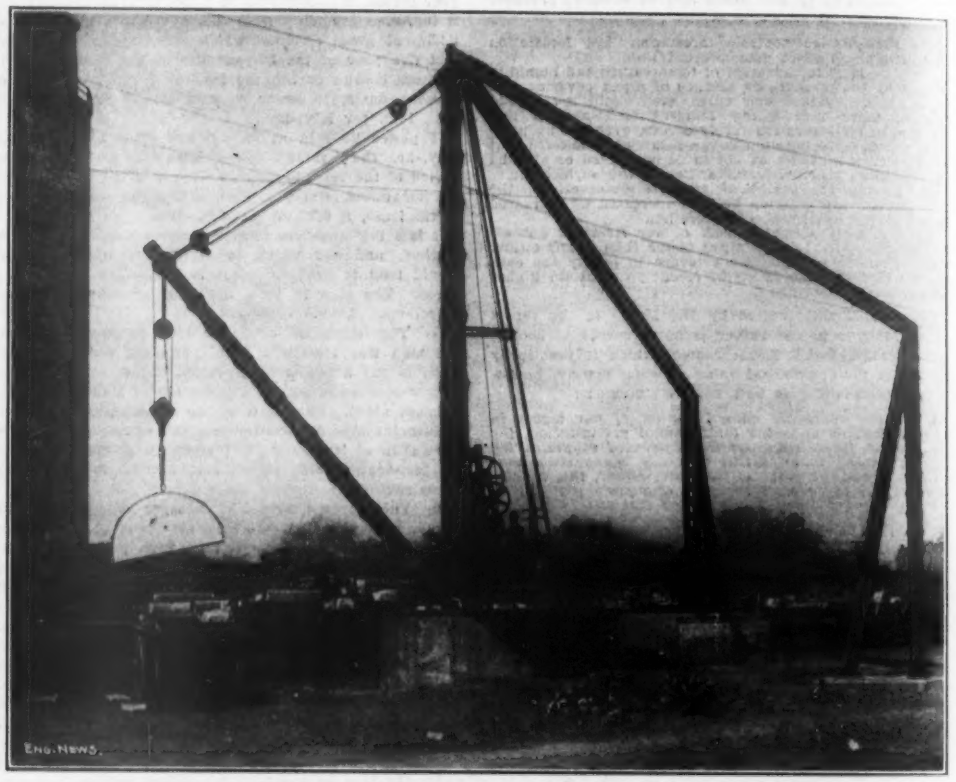
TERM OF PERMIT.—Clause 20 of the permit in force reads as follows:

> The permit hereby applied for shall cease and be void, upon the expiration of 50 years from the date of approval hereof, but it may then be renewed in the discretion of the duly authorized officer or agent of the United States, and upon such conditions as he may in his discretion fix: Provided that such officer or agent, in fixing such conditions shall consider the actual value at that time for power and all other purposes of the lines and rights of way within National Forests occupied and used under the permit hereby applied for and the actual value at that time of all improvements lawfully made by the permittee within National Forests under the permit hereby applied for, but neither the property of the permittee, if any, outside of National Forests, nor the permit, franchises, bonds, capital stock or other securities of the permittee shall be considered in fixing such conditions.

It will be noted that this clause contains no provision for taking care of the contracts which may be in force between the permittee (or his successor) and his customers at the expiration of the 50-year period, nor does the author find any provision covering this point elsewhere in the power agreement. It is obvious that by its absence the value of the permit during the latter years of its life is materially impaired. Power contracts are frequently, in fact generally, executed for periods of not less than five years and frequently for ten or even twenty years.

The contract agreement should include a clause guaranteeing for a period not less than five years subsequent to its termination, the fulfillment of contracts between the permittee and customers existing at that time.

THE PERMIT REVOCABLE.—Under the law as it now stands the Forest Service can grant to an individual or corporation seeking to develop water-power from Forest Reserves only a permit revocable by the Secretary of Agriculture in his discretion. The so-called "Second right-of-way" act is entitled "An Act relating to rights-of-way through certain park reserves and other public lands," and bestows authority in this matter upon the Secretary of the Interior. A later law, approved Feb. 15, 1901, transferred to the Secretary of Agriculture



A 15-TON ELECTRIC DERRICK FOR HANDLING RAILWAY FREIGHT.

responsibility for the execution of all laws relative to national forests.

No argument is necessary to demonstrate that a permit revocable in the discretion of the head of a department is not an adequate basis for financing an enterprise requiring investment of capital. This vital defect of the existing law to-day stands squarely in the path of legitimate and praiseworthy enterprise seeking to develop and utilize our many water-powers from forest reserves now wasted. Every proper influence should be brought to bear by those interested in the true conservation of our natural resources to secure a modification of the law removing this otherwise insuperable barrier.

An Alternative Plan.

The man who criticises adversely a plan which has been elaborated by others is not necessarily under obligation to suggest an alternative; and, moreover, in the judgment of the author, any plan which imposes a tax upon water-power or fuel is at best of doubtful wisdom. Assuming, however, that upon careful consideration the American people should decide definitely and finally to impose a tax upon natural resources of the public domain, to be used in conserving and developing those resources, it is perhaps not improper to suggest the outlines of a plan which from the standpoint of public policy appears preferable to that now in force. The essential features of the plan which he would suggest are the following:

(1) A tax imposed on all sources of power found

upon public lands—a royalty on coal mined and a rental upon water-power. The charge for water-power to be based, not upon an indefinite and disputed relation of forest covering and commercial value of the power, but upon the fact that the Government needs revenue to develop and conserve our natural resources, owns the power, and, as owner, possesses an unquestionable right to impose a charge for its use. The Federal Government is now selling coal lands on the public domain at prices which, on the average, approximate 0.1 ct. per ton of the coal which it is estimated the property can commercially yield. If the coal be used to produce power under average conditions this tax is substantially equivalent to 0.5 cts. per 1,000 KW.-hr., as against an average rental of 20.86 cts. per 1,000 KW.-hr. now imposed in the case of water-power. The theory of conservation unquestionably points to an increase in the price fixed for coal lands or a decrease in water-power rental, or both. By adjusting the charges for coal and water-power to approximate equality, as measured by their respective ability to produce power, the tendency of the present method to stimulate the use of coal for power purposes as against the use of water-power—a tendency which, as the author has stated, is in direct contravention of the fundamental idea of conservation—will be avoided and the aggregate revenue ultimately available to the Federal Government for the purpose contemplated will be enormously increased.

The general features of the present contract agreement enforced by the Forest Service as regards 50-year limit of the period of appropriation should be preserved. The other restrictions now imposed should also be retained except that certain clauses should be modified to meet the practical objections which have been pointed out, in so far as mature consideration may determine the validity of those objections.

The proceeds of royalties upon the sale of coal land and forest products and rentals of water-powers to be used to conserve our national resources by development under broad and systematic plans—to conserve forests, build dams, improve navigation and irrigate the arid lands.

(2) The charge imposed upon water-powers to be based upon the amount of water appropriated and the effective head resulting from the topography of the Government lands concerned.

Under the present plan, it is necessary to measure the water used in order to fix the third deduction from the charge based upon output. The difficulty of measuring water, therefore, must be met and it is as easy to fix the second-feet appropriated as to fix the deduction allowed for artificial storage by a permittee.

Under this plan it would be to the interest of the permittee to install a plant of high efficiency and not a plant of low efficiency as the present method of charging suggests.

An important practical point in this connection is the fact that the estimate of competent Government engineers, discussed with and agreed to by the permittee, would constitute a safer basis for the investor who may undertake to finance the enterprise than he now has in the data submitted for his consideration by the promoter.

(3) There is a third suggestion which perhaps may be worthy of consideration in view of the fact that conditions as regards cost of development and characteristics of the market for power differ so widely in various parts of the country. That suggestion is that the Government engineers of the departments or bureaus concerned prepare comprehensive preliminary plans for the development of water-powers of a given watershed and that these water-powers collectively or severally be leased to the highest bidder, the Government, of course, reserving the right to reject all bids.

[It was voted by the convention at which this address was presented, to ask the Directors of the American Institute of Electrical Engineers to bring this address to the attention of proper government officials as an expression of the sentiment of the membership.—Ed.]

A 15-Ton Electric Derrick for Handling Railway Freight.

Freight handling appliances are required at many railway terminals for loading and unloading heavy freight, and these machines are of various types to suit local conditions. Overhead traveling cranes and gantry cranes are used in some cases, but the revolving crane is the type most generally employed. The Minneapolis, St. Paul & Sault Ste. Marie Ry. has installed at its freight station at Minneapolis, Minn., a 15-ton revolving derrick of the stiff-leg type. A special feature of this derrick is that the boom (even at maximum reach) can revolve in a complete circle without fouling the supports, while the electric contacts are so arranged that the crane can revolve continuously in one direction.

All the members are of steel, as shown in the accompanying cut, and the stiff-legs are supported by A-frames which (as well as the mast) are anchored to concrete foundations. The mast is 40 ft. high, and the boom is 30 ft. long, while the topping of the boom gives a variable working radius of from 10 ft. to 30 ft., so that loads can be handled within a large range.

The electric current is led up through the foundation and the pivot of the mast to the contact rings, from which it passes to the 22-HP. variable speed motor. This is geared directly to the hoist. There are two drums, one for the hoisting cable and one for the boom topping lift; they are operated by friction clutches. The swinging is effected by rolling reversing frictions through gearing to an 8-ft. circular rack or bull gear. To provide against failure of the power line delivering current, a double-drum hand hoist or crab is mounted on the mast, and this can handle the same loads as the power hoist. The ropes, of course, would have to be transferred from the drums of the latter to those of the former hoist. All the machinery is mounted on the mast, and the levers are grouped conveniently for the operator. This derrick was built by the American Hoist & Derrick Co., of St. Paul, Minn.

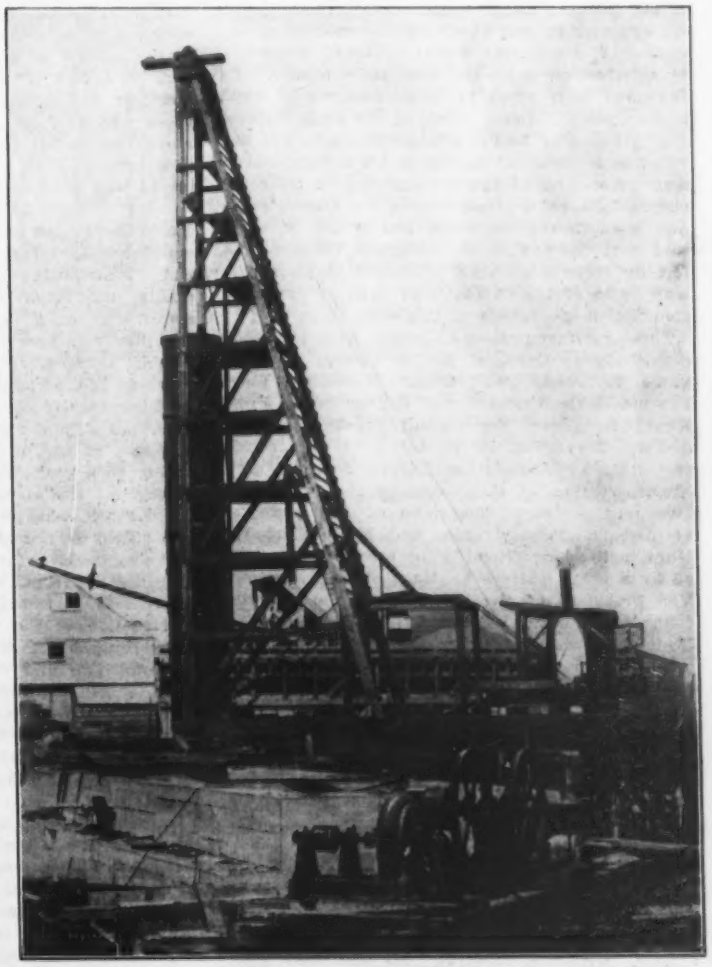
Sinking Large Steel Cylinders by Piledriver.

An ingenious expedient is being used by the San Francisco Bridge Co. in constructing concrete wharves at Fort Mason, San Francisco, Cal. The piers are supported by 48-in. cylindrical reinforced-concrete piers with enlarged base (6 ft. 6 ins. diameter), which are formed in place by concreting inside a wooden mold. To get reliable concrete and a satisfactory bearing, the concreting must be done in the dry, and for this purpose an enclosing steel cylinder is sunk to a tight seating into the bottom to serve as cofferdam to the mold. These cylinders are being sunk by driving down with a piledriver.

In similar wharf construction described in our issue of July 8, 1909, the wooden form was relied upon to do double duty, acting both as cofferdam and as concrete form. The wood-stave cylinder was fitted with a belled shoe and driven into a hard stratum in the harbor bottom so as to be tight enough for pumping out, inspecting and cleaning bottom, and placing concrete in the dry.

The steel cylinder cofferdam used in the work on the Fort Mason Wharves is driven through the bottom mud into hardpan, and is then baled out and the mud inside dug out to the required depth and foundation stratum, whereupon the wooden form is set in and the concrete pier constructed. After the concrete has set the steel cylinder is pulled and is redriven for another pier.

The steel cylinders are 7 ft. 7 ins. in diameter by 50 ft. long, and weigh 17 tons. A special piledriver was built for the work, with leads 90 ft. high. The hammer weighs 5,000 lbs. A heavy built-up driving block fitting over the head of the cylinder takes the blow of the hammer; in the photograph this lies at the extreme left, at the level of the piledriver sills. The pull required to draw the cylinders is in the neighborhood of 50 tons. Six-sheave blocks of 100 tons capacity are fitted to the driver. The driver engine is 8¼ × 10 ins., and the whole driver is carried on the falsework by sills 18 × 24 ins. by 60 ft. long.



SINKING A STEEL CYLINDER 7 FT. 7 INS. DIAMETER BY 50 FT. LONG WITH A PILE DRIVER, FORT MASON WHARVES, SAN FRANCISCO.

A WATER-SUPPLY TUNNEL BENEATH THE EAST River at Blackwell's Island, New York City, to connect the Croton water-supply with the Borough of Queens, has been authorized by the Board of Estimate and Apportionment. The tunnel will connect a 40-in. main in Manhattan with the 30-in. pipe in Long Island City. The estimated cost, as reported, is $1,150,000.

THE MALLET DUPLEX PUSHER ENGINES built by the American Locomotive Co. for the Delaware & Hudson Ry. have as one of their special features the use of very long boiler tubes. No portion of the barrel is given up for superheaters or feed-water heaters, as in many engines of this class. The smokebox is about 6 ft. long, and from its tube sheet extend tubes 24 ft. long to the tube sheet of a combustion chamber which forms a 4-ft. extension of the firebox; the inside dimensions of the firebox are 10 ft. 7 ins. × 9 ft. 7 ins. These engines weigh 222 tons, and have the entire weight carried on 16 driving wheels (in two groups of eight wheels each). In wheel arrangement they are of the 0-8-8-0 class. The cylinders are 26 × 28 ins. and 41 × 28 ins., with driving wheels 4 ft. 3 ins. diameter. The total heating surface is 6,276 sq. ft., of which 6,629 sq. ft. are provided by the tubes. The length of engine and tender over all is 90 ft. 6 ins., and their combined weight is over 300 tons.

These engines are for use on a 20-mile pusher grade from Stone Post to Ararat, on the Jefferson branch. The grade is 1.36% for six miles, and then averages 0.81% for 14 miles to the Ararat summit. This 20-mile grade is against the northbound traffic of heavy coal trains, the standard train weighing 2,600 tons. This train load is handled by an engine of the 2-8-0 class, weighing 126 tons, with 110 tons on the drivers, and having a tractive power of 49,690 lbs. On the 20-mile grade, however, two pusher engines of the same class were required, but the work of these two engines will be done more efficiently by one of the new Mallet engines.

Annual Meeting of the American Society for Testing Materials.

The thirteenth Annual Meeting of the American Society for Testing Materials was held at the Hotel Traymore, Atlantic City, N. J., June 28 to July 2, 1910. Following very closely the line of membership increase, as reported below, the attendance this year showed a marked increase over that of previous years. At the end of the meeting over 375 persons, mostly members, had registered for the technical sessions and the ladies present brought the registration close to 450. In accordance with the scheme inaugurated last year there were no contemporaneous sessions, in which different subjects were discussed in different rooms at the same time, a custom to which the Society adhered for some years, but the deliberations were extended over nine separate sessions in five days, each session being devoted to one branch of science. In this way, members whose interests do not extend to some one particular field are at liberty to examine the boasted attractions on and contiguous to the Boardwalk when that field is being covered in convention. At the same time this plan removes the desire for a dual personality manifested in the past by those members of broader and more catholic tastes.

To those who have attended the meetings of the Society since its beginning the absence of the former President, Dr. Charles P. Dudley, who died during the year just passed, was most keenly felt. The kindly smile, the generous sympathy, the straightforward friendliness that made the newest member feel at home, the appreciation of the younger man's effort, the deference to the senior's opinion and above all that marvelous capacity of elucidation which so often cleared a tense situation—all were most sadly missed. To few men is it given to be so universally loved and respected. One evening of the week, heretofore given over to the annual banquet, was devoted to a memorial session in his honor. Seven men prominent in the Society and in scientific circles delivered addresses upon Dr. Dudley's life and work in various fields, and it can be truly said that not one of the eulogistic tributes was felt by those who were privileged to know the man to be of the character of fulsome praise so common in memorials of this sort.

These commemorative addresses were by Theodore N. Ely, Chief of Motive Power, Pennsylvania Railroad; Prof. Edgar F. Smith, Vice-Provost of the University of Pennsylvania; Prof. Henry M. Howe, the present President of the Society; Lieut.-Col. B. W. Dunn, of the American Railway Association Bureau for the Safe Transportation of Explosives, etc.; Mr. W. H. Schwartz, a fellow townsman of Dr. Dudley's, at Altoona, Pennsylvania, and Mr. Robert W. Hunt, a life-long friend. The session was opened by a short address by Mr. Robert W. Lesley, Vice-President of the Society. At the end the following minute, written by Prof. Howe, Dr. Dudley's successor as President of the Society, was adopted to be recorded in the Proceedings of the Society:

> Let us record at once our deep grief and our deeper gratitude, our grief indeed at the loss of a great leader and dear friend, but above all, our gratitude that we have had the privilege of being led.
>
> Such measure of usefulness as our Society has had it owes in very large part to that leadership. Here was a most rare combination of qualities, the sterling, the intellectual, the human, the judicial, each on a high level, all combining to form a character, a personality, whose like we shall not look upon again.
>
> With a clear head to see the world's needs, to part the essential from the accidental and the merely concomitant, went the skillful and persuasive tongue to make clear to the rest of us what he had first made so clear to himself. With these went the perfect fearlessness, apparently even the unconsciousness of either danger or fear, which made him lead on where others would have flinched. With these again went his calm, clear, good judgment, which seemed to tell him spontaneously which among the good things that needed doing were the most worthy of being done, and what were the best and surest ways of doing them.
>
> With all these admirable qualities went that which was necessary to the accomplishment of his high purposes, his kindness of heart, his sympathy and his tact, which made us all his allies in what he undertook. Had he a proposal? Our affection and veneration for him made us almost its advocates before it was unfolded. Its intrinsic wisdom, and the clearness with which he expressed it, found an audience ready, almost anxious, and certainly expecting to be convinced.
>
> Great as were his tangible works, his greatest was the imponderable. Standing on a high platform, his call raised us towards his level, all the more effectively because of his complete unconsciousness of his own height. We who have known and loved him are for that knowledge and that love the better and the higher—how much, ah, who shall say?

At the death of Dr. Dudley, Prof. Henry M. Howe (Professor of Metallurgy, Columbia University) was elected as the American representative on the Council of the International Association for Testing Materials, as Dr. Dudley's successor, and thereafter was elected Acting President of the International Association. The balloting at the annual meeting resulted in the election of Dr. Howe as the President of the Society for the ensuing year. Prof. Marburg was continued as Secretary and Treasurer, and Mr. Robert W. Lesley as Vice-President, and Mr. James Christie as member of the Executive Committee. Dr. Howe's place on the Executive Committee, left vacant by his promotion to an ex-officio position on that committee, was not filled, but the revised constitution calls for four additional members of the Committee, so the election of all these members will probably be deferred until the adoption of the revision by letter ballot.

Business Session.

The membership of the Society has been steadily increasing and has now reached 1,280, an increase of 120 during the past year. In spite of this enlargement, with the consequent added total to the annual dues, the receipts of the Society are insufficient to meet its expenditures, so that at the end of this fiscal year there is reported a deficit of nearly $2,200, due mainly to the heavy expense of the publications. These publications can in no way be abridged, as they are probably the most valuable adjunct to the Society's work, reporting as they do the progress of the science of materials to those many members who find it unable to attend the annual meetings and forming a very necessary record to those who do hear the oral proceedings. To remove this deficit the Executive Committee this year proposed an increase in dues, which increase was accepted by the convention and is to be sent by letter ballot for final approval. Heretofore there have been but two regular classes of membership, "members" paying $5 a year dues and "contributing members" paying $50 annually, the latter not enjoying any privileges above that of a "member." The revised constitution will provide for two classes of membership, a "member," "a person not less than 30 years of age, corporation, firm, technical society, teaching faculty or library," paying $10 a year dues, and a "junior member," "a person less than 30 years of age on the date of his admission," paying $5 a year dues. This latter membership, having all the rights and privileges of a full membership, was provided for the younger men who might feel unable to pay the higher dues but who could get much help from a membership and whose aid would be of great benefit to the Society. Although it does not seem a strict construction of the revised constitution, it was stated by the Secretary that any one under 30 years of age and otherwise eligible could become a full "member" by paying the higher dues, if he so desired. Any member may compound his dues for life by paying $150 in the case of an individual, or $200 in the case of any corporation, or institution, or firm that exists in perpetuity.

By means of the added income from this increase in dues it is hoped not only to remove the deficit and to improve the clerical operation of headquarters, but also to place the publications of the Society in a much more desirable form. A Year-book is to be issued to each member, which will contain in addition to matter now in the annual pamphlet recording the work for the year, all of the standard specifications in their latest revised form. This will be a great convenience, saving as it will the hunting through various volumes to find the latest form of any specification.

Another revision of the Constitution to be submitted to letter ballot provided for an increase in the Executive Committee from the present seven to eleven members, so that the varied interests and different geographical districts may be more completely represented.

The Executive Committee also proposed a change in regard to the chairmanships of technical committees, which was the source of some discussion on the floor of the convention. Heretofore technical committees dealing with subjects having a commercial bearing have been appointed by the Executive Committee with an equal numeric balance between the representatives of consuming and producing interests, classing unattached experts with the representatives of the consuming interests. With the acquiescence of the producing interests the consuming interests were allowed to dominate. It was then provided that the permanent chairman of the committee should be elected by the committee from among the consuming interests or unattached experts. The report presented this year proposes that this chairman *may* be elected "from among the representatives *of* manufacturing interests by three-fourths vote of those present" at the first committee meeting.

This provision was opposed by members on the floor of the convention, as violating a desirable precedent of the Society, a precedent that did much to ensure fair action on the part of the committee and which added no little to the influence of recommendations and standards of the Society. The chairman of a committee has considerable power in shaping and directing the action of the committee and on that very account his election from the ranks of those producing a material *might* tend to produce criticisms of the work of the committee under his charge. In view of these arguments the convention voted its disapproval of the revised provision, but also voted that it should be sent to letter ballot, together with a list of arguments for and against the change, from which the members might make an unprejudiced decision on the question.

A motion was passed recommending that the Executive Committee consider the appointment of a committee to investigate the subject of the modulus of elasticity (Young's modulus) and to determine upon an exact definition of this constant, particularly in the non-ferrous metals.

COMMITTEE REPORTS ON SPECIFICATIONS.

Owing to the increasing number of committees and the complications resulting in their designation, a new system of nomenclature has been adopted. This does not change the names of the committees but merely the designating letter; thus, none of the committees in this report will have the same letter as assigned them in our previous reports. The new classification is as follows: A, Ferrous Metals; B, Non-Ferrous Metals; C, Cement and Clay Products; D, Miscellaneous Materials; E, Miscellaneous Subjects. The following new committees have been created and are in course of organization or have just been organized: A-2, on Standard Specifications for Wrought Iron; A-9, on Alloy Steels; A-11, on Metallurgical Research in Steel; A-12, on Tests of Steel Structural Members; B-2, on Non-Ferrous Metals and Alloys; D-9, on Standard Tests of Insulating Materials; D-10, on Standardizing Explosives.

The four following committees reported specifications to the meeting for adoption. These were passed and sent to letter ballot to become standards of the Society.

Methods of Testing.

Prof. Gaetano Lanza (Mass. Inst. of Technology, Boston, Mass.), Chairman of Committee E, on Standard Methods of Testing, submitted without change the report on standard methods of testing provisionally presented at last year's meeting and at that time held over for a year for possible criticism. Without any discussion the report was accepted and sent to letter ballot as a standard of the Society. This report was printed in full in pp. 263-272 of the Proceedings of the Society for 1909.

Staybolt Iron.

The standard specifications on this subject reported at last year's convention and referred

back to the committee for revision have been revised during the past year and as revised were accepted by the convention and sent to letter ballot for acceptance as standard. The accepted specification is the same as the one printed in Vol. VII. of the Proceedings of the Association, pp. 157-158, except for the following changes:

The addition of the following clause to the first sentence under "Process of Manufacture:"

"the basis of which must be pig metal and entirely free from any admixture of steel."

The omission of the following matter:

"The pile must be made up of a central core composed of bars from ½ to 1 in. square and be covered on all four sides with an envelope ⅝-in. thick as per sketch. This pile must be rolled to a billet, allowed to cool, again heated, and then rolled into bars of the required dimensions."

The substitution of a "Nick and Break Test" for the "Threading Test."

Timber.

Committee D-7 on Standard Specifications for the Grading of Structural Timber, by Mr. H. Von Schrenk (Consulting Engineer, St. Louis, Mo.), reported that during the past year the work of the Committee has been devoted largely to getting the various railways and lumber associations to adopt the Standard Specification for Yellow Pine Bridge and Trestle Timbers, as submitted last year, and the Committee reports that gratifying results have been reached along this line. The specification was adopted by both the Southern Yellow Pine Manufacturers' Association and the American Railway Engineering and Maintenance of Way Association substantially as submitted by the Committee. This specification has not been adopted by the Society formally, but this year it was accepted by the convention and is to be sent to letter ballot. Progress was reported on the standard specification for Douglas fir and Western hemlock bridge and trestle timbers. This specification was tentatively submitted with the report.

Standard Tests for Road Materials.

Committee D-4 on Standard Tests for Road Material, Mr. L. W. Page (U. S. Bureau of Public Roads, Washington, D. C.), Chairman, presented for letter ballot several specifications included in the report presented last year under the heading "Proposed Tests for Bituminous Compounds for Roads and Pavements, Including Method of Sizing and Separating the Aggregate in Asphalt Paving Mixtures." Along with this there was also presented a proposed tentative method of distillation of bituminous materials used in roadway construction. There was, however, some little discussion on the floor by members of the Committee as to the exact wording of this latter tentative specification, and the Chair ruled that its approval by the convention should only hold in case a letter ballot of the Committee showed unanimous consent to its presentation.

OTHER COMMITTEE MATTERS.

COLD-DRAWN STEEL.—Mr. C. E. Skinner (Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.) reported that Committee A-8, on Standard Specifications for Cold-Drawn Steel, of which he is chairman, had only a progress report to make, but that tests and investigations are so far along that it freely expected to present specifications at the next annual meeting. A number of tests are being carried out by various manufacturers over the country on what the Committee calls "standard automatic screw stock," and there have been prepared and printed blanks which the Committee will be very glad to supply manufacturers to furnish information as to the data desired.

CEMENT.—Mr. R. L. Humphrey, Secretary of Committee C-1 on Standard Specifications for Cement, reported that the U. S. Army has appointed a board to investigate the subject of cement specifications, and it is hoped that in the ensuing year the U. S. Engineer Corps will approve a specification more nearly in accordance with the Standard Specification of the Society, if not the same specification. The Secretary also reported that the Committee has under advisement for insertion in the specifications the matter of air separation as a determination of fineness and compression tests instead of tension, which latter has recently been adopted in the German standards.

CONCRETE AND REINFORCED CONCRETE.—It was reported that this Committee, which is the joint committee of three societies that reported a progress report about a year ago, has the criticisms of its report under consideration, but at present has no changes to recommend.

CAST-IRON AND FINISHED CASTINGS.—Committee A-3, Mr. Walter Wood (Philadelphia, Pa.), chairman, reported that none of its subcommittees had any changes to suggest in the present standard specifications. It was hoped that the sub-committee on Locomotive Cylinders would have certain minor changes to report but they were not ready in time for the convention. Mr. Wood made a personal report on the subject of international specifications for cast-iron, as discussed at the meeting of the International Association for Testing Materials at Copenhagen in September, 1909. Germany and the United States presented standard specifications for cast-iron to that meeting and the committee was instructed to study the various ones for report at the next meeting in 1912. Experiments are also to be made during the next two years in different countries to determine the most satisfactory length of "arbitration bar" to be used in cast-iron tests. It was also reported that British manufacturers have adopted the Society's Standard Specifications on Cast-Iron Pipe.

STEEL.—Committee A-1, on Standard Specifications for Steel, reported that it did not find it necessary to hold meetings during the past year. Its report to the Society consists of a report on the Copenhagen Congress of the International Association for Testing Materials, made by its chairman, Mr. Wm. R. Webster (Consulting Engineer, Philadelphia, Pa.). This report notes the presentation to the International Association of various specifications on steel products by representatives from Germany, England and the United States, and records the resolution of the Committee on Steel to the general effect that specifications for the testing of iron and steel should be put on a uniform basis throughout the civilized world. To this end the International Association appointed a committee from the three countries named, whose duty it shall be to correlate the various specifications on these subjects, and to attempt to present to the next meeting of the International Association a specification which will be acceptable to all three countries.

PAVING AND BUILDING BRICK.—Committee C-3 on Standard Specifications for Paving and Building Brick, through its chairman, Mr. L. W. Page (U. S. Bureau of Public Roads, Washington, D. C.), presented a progress report in which it was stated that no specifications on paving brick will be presented until further data can be gathered. During the coming year it is intended to make a number of tests on paving brick in various laboratories throughout the country. For this purpose the National Association of Brick Manufacturers have agreed to furnish a number of ten different kinds of paving brick. When the results of these independent tests are known, it is hoped that a specification may be prepared.

LUBRICANTS.—Prof. A. H. Gill (Mass. Inst. of Technology, Boston, Mass.) presented a progress report of Committee D-2, on Standard Tests for Lubricants, of which he is chairman. The report was mainly of progress toward a standard specification and contained an extended description of the various viscosimeters now being used in testing oils.

FATS AND OILS.—Mr. C. N. Forrest (N. Y. Testing Laboratory, Maurer, N. J.), Chairman of Committee D-3 on Standard Methods of Analysis of Fats and Oils, reported that a joint committee from a number of technical societies had been formed on this subject and that the Committee of the Society had a representation on this joint committee. Until the latter brought in a report the committee can report only progress.

WATERPROOFING.—Committee D-8, on Waterproofing Materials, has two sub-committees on waterproofing concrete, the first dealing with waterproofing by the incorporation of non-bituminous substances, the second with bituminous or fabrics. The Chairman of the Committee, Mr. W. A. Aiken (Philadelphia, Pa.), reported that the sub-committee on incorporated material had come to the conclusion (1) that the general effect of incorporated materials in concrete as a waterproofing agent was to reduce the tensile strength and (2) that the method by which such materials make concrete waterproof was by increasing the density, an effect that could be reached equally well by natural means, such as thorough mixing, well-graded materials, or even by the inclusion of such non-patented material as hydrated lime, colloidal clay, etc. The Committee has decided not to continue its investigations along this line any further.

The sub-committee on bituminous materials had no report to make except that the tests noted last year are still in progress.

In the discussion of this report Mr. Cyril De Wyrall (Chief Inspector, Interborough Rapid Transit Co., N. Y.), took occasion to call attention to the present insufficiency of waterproofing specifications and the need for the establishment of some standards that will insure watertightness. He said that although the present New York subway has been most unfortunate in the matter of watertightness, leaks through roof and sides regularly causing damage and expense, the specifications for the new subways contain the same requirements as to waterproofing as the old.

CLAY AND CEMENT SEWER PIPE.—Committee C-4 on Standard Specifications and Tests for Clay and Cement Sewer Pipe (Mr. R. Hering, N. Y., Chairman,) reported that it was collecting material on tests on such pipe and also upon tile for drainage and irrigation and hoped to make a report next year. Mr. C. W. Boynton (Universal Portland Cement Co., Chicago, Ill.,) moved that in view of the growing use of drain and irrigation tile and the acknowledged interest in those materials by the committee that the executive committee consider changing the title of the committee to Committe on Clay and Cement Pipe, leaving out the sewer. For some unexplained or at least indefinite reason, members of the committee so strongly objected to this change that Mr. Boynton withdrew his suggestion.

MAGNETIC TESTING OF IRON AND STEEL.—Committee A-6, on this subject reported a new chairman, Mr. C. W. Burrows (Bureau of Standards, Washington, D. C.,) and also the proposed methods of testing to be undertaken by the reorganized committee.

Preservative Coatings for Iron and Steel.

Committee A-5, on The Corrosion of Iron and Steel, Dr. Allerton S. Cushman (U. S. Bureau of Public Roads, Washington, D. C.), Chairman, reported that the work of the committee consisted in the care and supervision of the wire-fence panels at Pittsburg and the official inspection of the steel panels at Atlantic City. The Pittsburg wire-tests are upon various kinds of wire treated in different manner, so as to determine if possible the effect of various conditions on corrosion of the wire. It is reported that a sufficient time has not yet elapsed to justify a report on these tests.

ATLANTIC CITY STEEL PANEL TESTS.—These tests, as reported last year, are intended to reveal, as far as possible, the effect of pigment on the corrosion of metal, dividing the pigments into classes called, respectively, "inhibitive," "stimulative" and "indeterminate," according to their behavior in influencing corrosion of metal in the presence of water. The classification as made is specifically stated to be tentative, based on some preliminary tests, but should be of value in showing tendencies.

Panels, covered with these paints, were placed on a fence near the beach at Atlantic City, in the autumn of 1908, and the first official examination was made in April of this year, the results of the inspection being given in the report of the committee this year. This inspection was made by seven members of the committee

each working independently and giving to each panel a mark based on its chalking, checking, cracking, scaling and color. These results were presented in tabular form and are too lengthy even to abstract here, but the general conclusions of the committee are as follows:

The original object of these tests was to determine whether the results obtained under service conditions bear any relation to the inhibitive and stimulative effects obtained in the laboratory water tests which have been previously described and published. . . . It is the opinion of the committee that the panel tests have not progressed far enough as yet to justify definite conclusions being drawn. It is not only possible but probable that in the course of time many of the plates that are at present in good condition will begin to fail and fall below others which now show slight deterioration. It is apparent, however, that those pigments whose protective value depends upon the principle of chromate inhibition as well as those which produce basic reactions in water suspensions, have given a good account of themselves on the steel panels. . . . All these pigments are claimed to be good excluders and do not depend upon solubility in water, and consequently on any inhibitive value, for the protection provided. Beyond calling attention to this point the committee prefers to refrain from drawing conclusions at this time from the results of these tests.

The committee is unanimously of the opinion that up to the present time no differences are discernible in the duplicate protective coatings applied to different types of steel or to surfaces prepared in different ways. As would be expected, however, the panels which faced the ocean and acted to some extent as a wind break to the other lines, show slightly advanced deterioration.

PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS.—Mr. S. S. Voorhees (U. S. Geological Survey), Chairman of Committee D-1, with the above title, reported that his committee had now grown to 50 members, and it had been necessary to subdivide it into a number of smaller committees, each taking up some special subject. These sub-committees reported as follows:

HAVRE DE GRACE BRIDGE PAINT TESTS.—It was hoped last year that a report could be made this year on the behavior of the various paints on various panels and posts of the bridge of the Pennsylvania R. R. at Havre de Grace, Md., but the last periodical inspection by the committee showed that although 3½ years have elapsed since the paints were applied they are all in fairly good condition, and certainly are not ready to be stripped for inspection. The one deduction from this admirable wear is that the preliminary cleaning treatment, which was given to all of these members and the careful manner of paint application act advantageously as far as wear is concerned.

WOODEN PANEL TESTS, ATLANTIC CITY.—This test is completed and the final inspection is set down in the report of the committee. The deductions are too detailed to give here.

LINSEED OIL.—This sub-committee reported that a number of letters have been sent out to and received from various manufacturers by means of which the committee has been able to get a good idea of what a standard specification for linseed oil ought to be and, with the aid of tests to be carried out during the coming year, such a specification, it is hoped, will be presented next year.

VARNISH.—The sub-committee merely reported progress.

OTHER COMMITTEES.—The following committees reported progress: Committee B-1 on Standard Specifications for Hard-Drawn Copper Wire, Mr. J. A. Capp (Genl. Electric Co., Schenectady, N. Y.,) chairman; Committee D-9, on Standard Tests for Insulating Materials, C. E. Skinner (Westinghouse Elect. & Mfg. Co., Pittsburg, Pa.), chairman. Committee D-5, on Standard Specifications for Coal, Mr. G. A. Holmes (U. S. Geological Survey), chairman, did not report at all.

TECHNICAL PAPERS.

In addition to the committee reports there were presented some 35 separate technical papers on matters connected with the composition, manufacture and testing of materials. These papers, together with the discussion upon them, form a vast quantity of miscellaneous material which can only be abstracted here. Those interested further are referred to the Proceedings of the Society to be published later in the year.

TESTS OF STEEL AND WROUGHT-IRON BEAMS.—Mr. H. F. Moore read a paper with the above title, describing the first series of some tests now being made at the University of Illinois, a continuation of which it is intended to make in the future. The author stated that "the results presented should be taken as preliminary and tentative, and not in any sense as conclusive," so they will not be given here in full. The tests were upon 8-in., 18-lb. steel I-beams without side restraint and in spans of 5, 7.5, 10 and 20 ft., and upon various I-beams some in pairs of two bolted together with cast-iron separators and some restrained against compression flange buckling, upon built-up wrought-iron girders with and without lacing and upon a wrought-iron channel section built up bridge post. The machine was so arranged that the beams were loaded at their third points and readings were taken upon deflection, longitudinal fibre deformation and side-wise motion of the beam. Pieces cut from the flange, root and web beams were also tested in tension.

The modulus of rupture exceeded but slightly the yield point of the material as determined by tension tests of specimens but in every case it was much less than the ultimate tensile strength of the material. In the beams where there was restraint against sidewise motion, the beams failed by gradual bowing in the plane of the load, and the failure was very slow. In the beams where there was no side restraint or partial restraint only the failure was by side-wise buckling of the compression flange, and it was more sudden than any of the bowing failures. In all cases of failure by twist of web the beams were comparatively short and deep.

In the tensile tests of pieces taken from the web, flange and root, respectively, there does not seem to be any fixed relation of values. Thus, out of nine beams reported, the piece from the web had the highest tensile value in four, the second highest in two and the lowest in three; the similar figures for the flange are four, three and two and for the root, one, four and four. Giving each of these proper weight the relations between the tensile values of pieces taken from the web, flange and root, respectively, are 19, 20 and 15, so it will be seen that from these tests no definite conclusions as to the strength of material in the various portions of the beam can be drawn.

STRENGTH OF STEEL FROM I-BEAMS.—Mr. E. L. Hancock reported on a series of tests in which test pieces were cut from both I-beams and Bethlehem H-beams at the web, flange and root, respectively, as in tests noted above in the abstract of Mr. Moore's paper. As a result of these tests Prof. Hancock concludes that

The elastic limit varies considerably for material cut from different portions of the beam, both standard and Bethlehem, being lowest in root of web, higher in flange near root, and highest in web. This confirms the work of Professor Marburg.

The indications are that there is considerable difference chemically in the material in different parts of the beam. It is desirable that these chemical tests be made and recorded as a part of this investigation.

The appearance of the fractured pieces indicates a considerable variation in the density of the material throughout the beam, due probably to the work of rolling. The thin beams show material superior to that of the thick beams.

Giving weights to the tensile values as observed in Prof. Hancock's tests the relative tensile strength of pieces taken from 11 beams shows the ratio to be 27:21:18 for pieces taken from web, flange and root, respectively, which differs somewhat from the 19:20:15 ratio deduced by us from Mr. Moore's paper.

Prof. Hancock had intended to make chemical analyses of the various pieces, but was not able to do so in time to report to the convention.

(To be concluded next week).

AN APPROPRIATION OF $1,000,000 to protect lands and property adjacent to the Colorado River, in Southern California, was granted by Congress just before adjournment. This was in response to a special message from President Taft in which he stated that an appropriation was needed to protect "thousands of people and millions in land values" below the "locality in which a break occurred in 1905, and was remedied by Mr. Harriman's acting at the request of my predecessor."

Applying an Industrial System for Efficiency in Technical Instruction.*

By S. E. SLOCUM.†

DIFFERENCES BETWEEN SCHOOL AND INDUSTRIAL LIFE.—The present general demand for industrial and social efficiency has resulted in a new estimate of educational values. This is apparent in the popular tendency to consider education as a purely business proposition and rate its effectiveness on the basis of immediate practical returns. Although the various attempts to meet this demand by means of trade and industrial schools and other forms of special training have not proved wholly satisfactory, the general discussion which these efforts have aroused has made one fact clearly apparent, namely, that the discipline of the school is different from that of practical life. The extent of this difference seems to be also more or less definitely settled, such authorities as Mr. Fred. W. Taylor and others of wide experience in commercial lines being agreed that the average technical graduate requires two years of practical experience to place him in the proper relationship to his work. The most recent, and perhaps the most interesting, attempt to remedy this difficulty is the plan of industrial cooperation which has been developed chiefly with a view to giving the student practical discipline while still pursuing his theoretic instruction along orthodox lines. In reality this solution of the problem begs the question, as it delegates the task of commercial discipline to the shop instead of assuming responsibility for it as a practical feature of modern education.

The difficulty in making the transition from school to shop seems to lie in their characteristic difference of attitude towards their work. In advanced scientific work there may be good reason for the lack of sympathy of the man of affairs with the scientist, as their interests are widely different and demand types of ability which usually have little in common. In technical education, however, their interests are much more nearly identical, and whatever divergence they exhibit hinges not on aim but on method. Our educational system is the product of a gradual evolution and in consequence its methods tend toward a certain fixed academic standard. Our industrial system, on the other hand, has been completely revolutionized during the past fifty years by the introduction of automatic machinery and the pressure of competition. Commercial methods of to-day are radically different from those of even one generation ago, as is apparent in the highly specialized modern business organization. These new economic conditions are necessarily of fundamental importance to technical education, the chief distinction between academic and technical instruction being that the latter, to be effective, must adapt itself to conditions over which it has no control. This necessity is gradually modifying the content of technical courses, especially as concerns the nature and amount of fundamental subjects like mathematics, and must also be recognized eventually as determining the method of instruction.

To increase the practical efficiency of technical instruction, the most promising plan seems to be to study business methods which are proving commercially successful. This by no means implies the commercializing of education, as the chief function of the school requires that it stand in an essentially different relationship to the student from that of the employer. It is entirely feasible, however, to make such changes in the method of instruction as to bring the student into a more practical relationship with his work, and to accustom him while in school to that form of discipline which he will later experience. In accomplishing this result, modern business experience suggests that the idea of primary importance is that of a definite daily task with responsibility for results. By this is not meant a formal program of instruction, but a specific piece of work assigned daily, of such difficulty as to require the student's full time and ability, and for which he is held strictly accountable as to results.

In order to concentrate effort upon the daily task as the central feature of instruction, the first essential is to economize time in other directions by thoroughly systematizing the work of the class room. To this end, it is necessary to modify somewhat the ordinary methods of instruction such as the lecture and recitation. The lecture system, as a matter of fact, is a purely academic survival, while the same is true of the recitation or Socratic method as implied by its name. The most serious objection to such methods, as applied to technical instruction, is that they place the student in a purely receptive attitude, and thereby encourage the formation of habits which have no parallel in business experience. The tendency to acquire such habits is already making itself felt as a practical difficulty, and constitutes the basis of the objections raised by manufacturers to the employment of recent technical graduates.

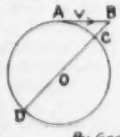
*A paper read at the Annual Convention of the Society for the Promotion of Engineering Education, June 23-25, Madison, Wis.

†Professor of Applied Mathematics, University of Cincinnati, Cincinnati, Ohio.

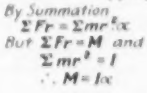
INFORMATIONAL ASPECT OF TEACHING.—As a preliminary to the real business of instruction the informational aspect of the course must first be considered. In the present day of technical literature it is important that the student learn to consult it intelligently and also form the habit of independent study. For this reason, if no other, it is advisable to select a standard text as the basis of instruction. A complete and systematic outline is thus provided without loss of time, and the text may also be so chosen as to be of value to the student as a future reference and form the nucleus of a professional library. The latter feature is one which is of considerable importance to the student but is not usually given proper attention by the instructor.

If, for any reason, it seems desirable to the instructor to supplement the text, the method most economical of time and effort and most effective as regards results is to prepare the notes in advance in such form that they may be reproduced mechanically. For instance, the writer finds it desirable to give his students a brief syllabus of mechanics in order to impress them with the unity of the subject by correlating fundamental principles. This outline is prepared in the form of tracings from which each student is required to make a set of blue prints at his own time and expense. Two pages of this outline are shown herewith. By this means it is possible to avoid the loss of time spent in dictation, and other undesirable features incident to the lecture system and student notes.

OUTLINE OF MECHANICS.
Kinematics Motion.

	Linear Motion.	Angular Motion.
Notations.	s = Displacement v = Velocity a = Acceleration v_0 = Initial Velocity F = Force $w = Fs$ = Work m = Mass t = Time Ft = Impulse mv = Momentum	θ = Displacement ω = Velocity α = Acceleration ω_0 = Initial Velocity M = Moment of Force $W = M\theta$ = Work I = Moment of Inertia Σmr^2 t = Time Mt = Impulse $I\omega$ = Momentum
Definitions.	$v = \frac{ds}{dt}$ $a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$	$\omega = \frac{d\theta}{dt}$ $\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$
Uniformly Accelerated Motion. Accel. = Constant.	$v = v_0 + at$ $s = v_0 t + \frac{1}{2}at^2$ $v^2 = 2as$	$\omega = \omega_0 + \alpha t$ $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ $\omega^2 = \omega_0^2 + 2\alpha\theta$
Derivation of above Formulas.	$\frac{d^2s}{dt^2} = a$ $\frac{ds}{dt} = v = at + c_1$ $s = \frac{1}{2}at^2 + c_1t + c_2$ If $t=0$, $v=v_0$ $\therefore c_1 = v_0$ If $t=0$, $s=0$ $\therefore c_2 = 0$	$\frac{d^2\theta}{dt^2} = \alpha$ $\frac{d\theta}{dt} = \omega = \alpha t + c_1$ $\theta = \frac{1}{2}\alpha t + c_1t + c_2$ If $t=0$, $\omega=\omega_0$ $\therefore c_1 = \omega_0$ If $t=0$, $\theta=0$ $\therefore c_2 = 0$
Relation between Linear and Angular Motion.	$v = r\omega$ $a_t = r\alpha$ a_t = Tangential Component of Acceleration $a_n = \frac{v^2}{r} = r\omega^2$ a_n = Normal " " "	
Derivation of First Two Formulas.	Arc $AB = ds = rd\theta$ $\frac{ds}{dt} = r\frac{d\theta}{dt}$ $v = r\omega$	$v = r\omega$ $\frac{dv}{dt} = r\frac{d\omega}{dt}$ $a_t = r\alpha$
Derivation of Normal Accel. for Uniform Circular Motion.	 If Body at A was free it would naturally proceed in Direction of Tangent AB and in time t it would reach B where $AB = vt$. Since it is found at C instead of B, it must have been acted on by a Central force. Let a_n denote the Normal Acceleration due to this Force; Then $BC = \frac{1}{2}a_nt^2$ By Geometry $BC \times BD = \overline{AB}^2$, and in the Limit BD approaches $2r$. Hence $\frac{1}{2}a_nt^2 \times 2r = v^2t^2$ from which $a_n = \frac{v^2}{r} = r\omega^2$	

OUTLINE OF MECHANICS.
Dynamics (Force).

	Linear Motion.	Angular Motion.
Fundamental Law	$F = Ma$	$M = I\alpha$
Discussion and Derivation.	By Experiment $F \propto a$ (Newton's 2nd Law) $\therefore \frac{F}{a}$ = Constant, say m, whence $F = ma$. m = Intrinsic Property of Body called its Mass. Mass = Measured Inertia. If $F=0$, then $a=0$ and hence $v=0$, or a Constant, which expresses Newton's First Law. F = Impressed Force; ma = Kinetic Reaction, or Inertia Force. Equality $F=ma$ expresses Newton's Third Law.	 From $F=ma$ $Fr = mra$, or since $a = r\alpha$ $Fr = mr^2\alpha$ By Summation $\Sigma Fr = \Sigma mr^2\alpha$ But $\Sigma Fr = M$ and $\Sigma mr^2 = I$ $\therefore M = I\alpha$
Principle of Work and Energy.	$W = Fs = \frac{mv^2}{2} - \frac{mv_0^2}{2}$	$W = M\theta = \frac{I\omega^2}{2} - \frac{I\omega_0^2}{2}$
Derivation.	$F = ma$ $v^2 = v_0^2 + 2as$ $\therefore as = \frac{v^2}{2} - \frac{v_0^2}{2}$ and $W = Fs = mas = \frac{mv^2}{2} - \frac{mv_0^2}{2}$	$M = I\alpha$ $\omega^2 = \omega_0^2 + 2\alpha\theta$ $\therefore \alpha\theta = \frac{\omega^2}{2} - \frac{\omega_0^2}{2}$ and $W = M\theta = I\alpha\theta = \frac{I\omega^2}{2} - \frac{I\omega_0^2}{2}$
Principle of Impulse and Momentum.	$Ft = mv - mv_0$	$Mt = I\omega - I\omega_0$
Derivation	$F = ma$ $v = v_0 + at$ $\therefore at = v - v_0$ and $Ft = mat = mv - mv_0$	$M = I\alpha$ $\omega = \omega_0 + \alpha t$ $\therefore \alpha t = \omega - \omega_0$ and $Mt = I\alpha t = I\omega - I\omega_0$
D'Alembert's Principle.	$F - m\frac{d^2s}{dt^2} = 0$	
Explanation and Use.	$F = ma$, where F = External Impressed Force and a = Acceleration produced. Introduce another Force P, given by $P = -ma$. Then by Addition, $F + P = 0$, i.e. the Body is in Equilibrium under Action of F and P. $-P$ is called the Kinetic Reaction, or Reversed Effective Force, since $P = -F$. By introducing this Idea of Kinetic Reactions equilibrating the Impressed Forces, all Problems in Dynamics are reduced to Statical Problems. This is called D'Alembert's Principle and is usually expressed in the Form $F = -m\frac{d^2s}{dt^2} = 0$	

INDUSTRIAL DISCIPLINE IN SCHOOL.—The aim of technical instruction, however, is by no means purely informational. The ability of an instructor to anticipate a student's difficulties and dispose of them readily by a clear explanation of facts is therefore not a sufficient criterion of his fitness for his work. To fulfill his function as a teacher it is essential that he afford his students the discipline of independent continuous effort. In all practical walks of life success is based on efficiency in securing results, and this idea must dominate class room methods if they are to be effective as a practical discipline. The Taylor system of shop management shows how the scientific application of this idea may be used to increase commercial productiveness. Although devised from a purely commercial standpoint, the Taylor system seems to have certain features especially adapted to technical instruction, and can be so applied with but a slight modification of existing methods.

The plan which most readily suggests itself for this purpose is the preparation of a card index of practical problems, so arranged as to systematically cover the given field of instruction. By the distribution of these cards a class can be set at work simultaneously with no loss of time, and kept at work continuously, while at the same time a separate piece of work may be assigned to each. The system is also sufficiently elastic to be readily adapted to special needs, and to grow in whatever direction experience may dictate. The distinctive features of this method are that the class can all be kept at work continuously and independently for the entire period spent in the class room, while the time of the instructor is also occupied to the best advantage in overseeing the work, and giving such explanations or references as may be necessary. A few cards are shown herewith from such an index which the writer has had in use for some time with his classes in mechanics.

403

A flywheel weighing 5,000 lbs. and having a radius of gyration of 3 ft. is keyed on a shaft so that its plane makes an angle of 1° with a plane perpendicular to the axis of the shaft. Find how much this obliquity increases the reactions on the bearings when revolving at 150 r. p. m.

112

What electrical HP. can be delivered at the switchboard by a water-power plant which has a water-supply of 200 cu. ft. per sec. under a head of 75 ft. when the water-wheel and pipe-line losses are 25% and the generator and station losses are 20%.

158

A shaft and pulley keyed to the shaft are rotating at 200 r. p. m., the total moment of inertia of pulley and shaft being 500 lbs. per sq. ft. A loose pulley at rest on the shaft is suddenly connected up with the fixed pulley by means of a clutch. If the moment of inertia of the loose pulley is 300 (lbs. ft.²), find the angular velocity with which the whole will revolve.

7

A cross compound engine indicates 120 HP. at 40 r. p. m. The fluctuation of energy per stroke is 12%, and the fluctuation of speed is 2% on either side of the mean. Diameter of flywheel 10 ft. Find the weight of the rim.

567

A shaft making 180 r. p. m. carries a pulley weighing 75 lbs. whose center of gravity is ⅛ in. from the axis of the shaft. Find the outward pull exerted. If the pulley has a solid web ⅛ in. thick, find where and how large a hole must be drilled in it to balance its eccentricity. Material weighs 480 lbs. per cu. ft.

135

Water flowing in a pipe 100 ft. long with a velocity of 30 ft. per sec. is shut off in 1/10 sec. by means of a valve. Find the increase in pressure near the valve.

To be effective as a discipline it is essential to have some simple plan whereby each student can record the results of his work. This may be done by requiring him to fill out a slip at the end of each class period with the number of his problem and his results, with the clear understanding that the only credit given is based on the correctness of these results. This method discourages the common habit of soldiering which has been found to be so destructive in commercial life, and stimulates the student to complete each piece of work undertaken. By filing these returns the instructor is able to tell at a glance the exact status of each student's work. Still more important is the fact that each man's work must stand on its own merits, there being no chance for deception or discrimination, and no need of special tests or final examination.

SECURING INTEREST.—No system of instruction is complete which neglects the important item of interest. So far as present purposes are concerned, interest may be defined as arising from the discovery of new aspects of familiar facts. This is essentially the definition given by Herbert, who expresses it by saying that interest is based on apperception. The problem of arousing interest, then, becomes one of correlating the subject of instruction with the ordinary affairs of every-day life or something equally familiar. The lack of interest displayed in a subject like mathematics for instance, is often due to the fact that the concepts and their applications have no apparent relation to any fact of experience, and the student lacks the imagination necessary to discover interest in abstract relations. The practical and theoretical sides have thus come to be regarded as conflicting aspects instead of being perceived in their true supplementary relation. The instructor should therefore not rely entirely upon his authority for the enforcement of the daily task, but should keep the requirement of interest constantly in mind.

The method adopted by the writer, with his classes in mechanics, indicates one way, at least, in which this may be accomplished. The classes of cooperative engineers at the University of Cincinnati were made the subject of experiment. This consisted simply in urging each student to bring to the class room for solution any problem in mechanics which might come under his observation in the shop. This plan, although simple, was found to serve a variety of objects. Among others, the student is made to feel that his instruction has a vital relationship to his work, and vice versa. Responsibility for a problem also leads to more careful habits of observation, especially as regards essential facts or dimensions, and the fundamental principles involved. As typical of the variety of interest which may be thus aroused, a few of the original problems obtained in this way are stated below.

To determine the hoop stress in the retaining rings of a commutator running at 3,600 r. p. m. and the shearing stress in the copper plugs of the rotor. This was a problem which had been discussed by the mechanics in the erecting shop, but which they had been unable to solve.

To determine the maximum allowable speed for a small motor resting on two wooden joists placed across an

opening in order not to endanger these joists by excessive vibration. This was a simple practical problem in vibrations, of general interest to the entire class.

To determine the efficiency at different inclinations of a universal joint transmission in use on a milling machine. This is an original problem which seems to have never been solved, and the results when plotted graphically proved to be of special interest.

To calculate the fluctuation coefficients for the flywheels manufactured by a local engine company, and to compare the rational constants so obtained with the empirical constants given in the firm's handbook. In this case the shop foreman became interested and the student came back with a request for literature on the subject.

To determine the efficiency of the sliding-gear transmission on a certain type of milling machine. In this case the student took his results to one of the engineers of the company. After discussion the president of the firm was called in, and it developed that the student's results were almost identical with those obtained empirically by the company from a series of long and costly experiments. Aside from the immediate educational value of the problem, the effect in this case was to raise the shop standing of the student.

To compute the maximum deflection of a loaded planer rail. This was a composite problem, involving the reading of technical blue prints, plotting of cross sections, determination of areas and moments of inertia, original formulas for the deflection of beams of variable section, the general theory of torsion and exact numerical calculations. The results were found to be of sufficient interest for publication, and the article will shortly appear in one of the engineering journals.

This method of stimulating interest is not peculiar to this particular subject of course, but is universally available. For instance, in elementary mathematics there is a wealth of practical and familiar material such as the heating and ventilation of buildings, the estimation of various quantities used in the building trades, simple geometrical constructions used by ordinary mechanics, and any number of other things in which the boy will learn to trace out mathematical relations for himself if he is started on the right track and receives proper encouragement. In high-school mathematics a still broader field is opened up by such subjects as mathematical geography, health and vital statistics, the system of taxation, and similar topics of common general interest, while, at the university level, the mathematical aspect of all scientific subjects affords abundant material of the most valuable kind. The material for stimulating interest is in every case that which is nearest at hand and of most vital importance. What is needed to utilize it effectively is resource on the part of the teacher and proper balancing with the routine of the daily task.

Wooden Arch Centering for a Norwegian Masonry Arch Bridge.

The new railway from Christiania to Bergen, Norway, crosses the Hallingdal river at Svenkerud by means of a stone arch bridge of 144.3 ft. (44.0 m.) span. This is the largest masonry arch on the Scandinavian peninsula. The arch has a rise of 21.6 ft. (6.6 m.), a crown thickness of 5.25 ft. (1.6 m.), and a thickness at springing of 8.20 ft. (2.5 m.). The short working season made it necessary to provide centering which could be left in place over winter, and to this purpose the bad ice and flood conditions dictated a single-span centering-frame. A braced arch built of timber was used, as shown in the sketch Fig. 1 herewith. Fig. 2 gives it more in detail, together with the auxiliary trussed girders employed for erecting the centers themselves. Both sketches are reproduced from the "Zeitschrift des Vereines deutscher Ingenieure" of April 16, 1910, containing a long article on the new railway.

The drawings seem to show that the blocking of the arch lagging included sand-boxes, as a means for striking centers. The spacing of the blocks would make the load per box 10 to 15 tons.

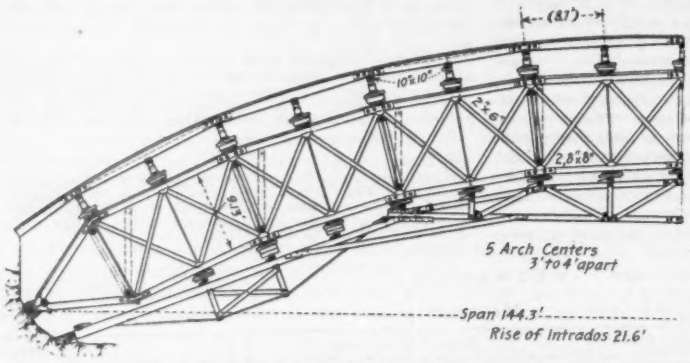


FIG. 2. TIMBER ARCH CENTERING AND AUXILIARY TRUSSED BEAMS.

The auxiliary trussed beams were used because of the following circumstances: Drifting of snow in the river gorge prevented the formation of solid ice, on which the centers could have been supported during erection. By digging trenches in the packed snow and running water in, a sort of ice bridge was made, capable of supporting light loads. Timbers frozen in this ice gave a footing for setting up the light trussed beams. When these were connected up, the main centering frames were erected upon them on wedge blocking, being swung clear as soon as connected.

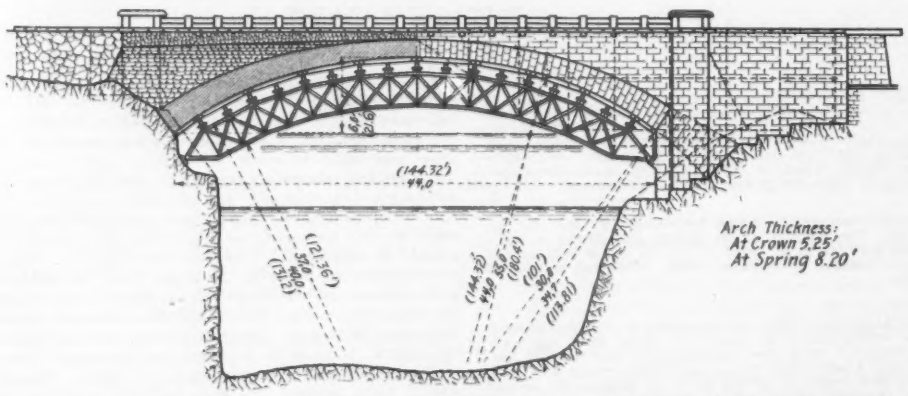


FIG. 1. SINGLE-TRACK MASONRY ARCH BRIDGE WITH TIMBER ARCH CENTERING, SVENKERUD, NORWAY.

The Forest Products Laboratory at the University of Wisconsin.*

By WM. L. HALL.†

An advance in forest conservation is realized in the establishment at Madison, Wis., of a thoroughly equipped wood-testing laboratory [recently opened—Ed.].

The wood which we cut down in the forest each year, if compacted together, would form a solid cube ½-mile square. It is taken from the forest by many industries. The lumber industry takes 42%; cordwood, 32%; fence posts, 9%; hewed railway ties, 7%; cooperage and pulpwood each, 2%. In manufacturing sawn lumber and its use by the industries, about 67% of the wood which grew in the tree is lost. In cordwood the loss is as low as 5%, and in posts and rails it is only 20%. In hewed cross-ties, however, the waste runs to 70%, none of which can be used; and in cooperage stock waste reaches the enormous figure of 78%. Taking these several items which together take 94% of the wood in the forest, we find that their combined waste amounts to 38% of the total.

To aid in saving this vast waste is the work of one entire branch of the Forest Service, the Bra[nch] of Products, and it is the direct purpose of the [For]est Products Laboratory.

The value of laboratory work in the economi[c use] of wood has already been fully tested by the [For]est Service. For several years small timber-testing [la]tories have been conducted in cooperation with Y[ale] and Purdue universities and the universities of Cali[fornia], Colorado and Washington. Some excellent results have been obtained in determining the strength and [other] properties of our commercial woods. Wood-using [indus]tries and engineers have benefited by the information thus obtained, and the tests of the Forest Service now [form] the basis of the specifications used in several important industries. Confined to timber testing, the work of these laboratories was too much restricted to yield the most important results. Facilities were needed for chemical studies, for wood-fiber investigations, for experiments in preservative treatment of wood, but none existed.

An appropriation was requested from Congress, but was not secured. After considering many possibilities, we at last hit upon the idea of enlisting the aid of a university to secure the needed facilities. After careful consideration, the University of Wisconsin was selected as having made an entirely satisfactory proposition and as presenting on the whole the most favorable conditions for work such as the Forest Service intended to do.

By the terms of the agreement the University has erected a building at a cost of about $50,000, and will supply free of charge the heat, light, water and power required in the work. The Forest Service has supplied the testing machines and other apparatus and will furnish the force of 40 experts and assistants to carry on the work. By this plan of cooperation the United States secures the largest and most completely equipped wood-testing laboratory in the world.

As to organization and working space, the laboratory is divided into three groups of three sections each. The first may be designated the chemical group. In it are the sections of chemistry, pulp, and distillation. The section of chemistry devotes itself to the study of the chemical constituents of wood and the composition of wood preservatives. The section of pulp investigations studies the fiber characteristics of woods to determine their value for various classes of pulp. The immediate work of this section, for which Congress has made a special appropriation, is to determine whether it is possible to find a substitute for spruce in the manufacture of ground wood pulp. The section of distillation has the interesting and important field of developing chemical by-products of wood by distillation processes. Undoubtedly, this section is to have great direct importance in reducing wood waste because many of our commercial woods are rich in such materials as alcohol, turpentine, oils and gums.

The second group of sections may properly be called the physical group, and contains the sections of wood preservation, pathology, and wood physics. The treatment of wood to improve its durability is rapidly becoming an important industry, and in the future it will work a great reduction in the waste which takes place in use because of decay, insects, and marine borers. Many of its fundamental problems are yet to be solved, however, and on these the laboratory will work. Closely allied with wood preservation is the section of pathology, which studies the diseases which prey upon woods. By an advantageous cooperative arrangement the Bureau of Plant Industry will man this section and supervise the technical structure of wood and the relation between structure and physical properties such as strength, toughness, and penetrability to liquids.

The third group contains two sections, which rest substantially on mechanical engineering. It may, therefore, be called the engineering group. The first of these is timber testing, which aims to build up, through mechanical tests, a rating table for the properties of our commercial woods. By means of the figures, when secured, we may classify woods according to their relative value for specific purposes. The second section is that of engineering, and has to do mainly with design work. Whatever is accomplished in cutting down wood waste in any line will depend in great part upon the efficiency of the machines which will be designed to do the work. This section is consequently a very important one. Third in this group is the section of maintenance, which looks out for the general maintenance and unimpeded operation of the laboratory.

Over all the sections, and in charge of the laboratory is the director, Mr. McGarvey Cline. He has as assistant directors Mr. H. F. Weiss and Dr. H. S. Bristol.

Correlated with the Forest Products Laboratory is the

*Abstract of a paper in "American Forestry," June, 1910.

†Assistant Forester (in charge of Branch of Products), U. S. Forest Service, Madison, Wis.

Office of Wood Utilization, with headquarters in Chicago. Its work is statistical, and it is constantly gathering facts and figures which will promote economy in the use of wood. It makes studies of the wood-using industries of cities and states, learns their requirements, and aids them in finding supplies of cheap and abundant woods to take the place of scarce and costly ones. It finds out what the waste is and proposes methods for its reduction. It is also gathering a record of wholesale lumber prices at the mills and in the principal distributing markets. In charge of the Office of Wood Utilization is Mr. H. S. Sackett, in the Fisher Building, Chicago.

The laboratory and the Office of Wood Utilization are represented by branch offices in Washington, Denver, San Francisco and Portland, Ore. These carry on the work in certain districts. The office which has administrative charge of all the several lines of work, already mentioned as the Branch of Products, has hitherto been in Washington, but on June 1 was transferred to Madison, from which place the assistant forester in charge will report to the forester in Washington.

All work conducted by the Branch of Products is done in close contact and cooperation with the lumbering and wood-using industries. It aims for practical ends which are linked with the processes of those industries and which can only be accomplished through the improvement of their processes. Consequently, it must keep in close touch with the industries to succeed at all, even in a minor degree. The industries do not resent this policy, but appreciate and favor it.

A BUTTING COLLISION NEAR MIDDLETOWN, Ohio, occurred on July 4, between a freight and a passenger train on the Cincinnati, Hamilton & Dayton Ry. Of the 19 persons killed outright, 18 were passengers. About ten others were injured, two of whom died later. The passenger train was known as the Cincinnati section of the 20th Century Limited and would ordinarily have been operated over the Cleveland, Cincinnati, Chicago & St. Louis Ry. On the day of the collision, it was detoured over the C., H. & D. Ry. on account of a freight wreck on the C., C., C. & St. L. tracks, at Genoa, Ohio. In addition to its regular crew it carried a pilot engineer of the C., H. & D.

The accident is ascribed to a confusion of meeting orders. The passenger train struck the second section of the freight while the latter was on its way to the siding just north of Middletown. Behind the passenger locomotive was a combination baggage car and smoker, followed by a day coach and a chair car. All the killed and injured were in the first two cars, which were smashed to pieces.

A MINE HOIST ACCIDENT AT HARRISBURG, PA., June 30, in a mine owned by the Lykens Valley Coal Co., resulted in the death of three men and the injury of two others. The men were being hoisted up a shaft and were nearly at the top when the cable gave way, dropping them to the bottom, 500 ft. below.

A POWDER MAGAZINE in the store of the Graves Mercantile Co., at Boulder, Mont., was exploded July 1 by a rifle bullet shot through the wall of the building in target practice. Six persons were killed and about 20 others injured. Several buildings were wrecked, including the telephone exchange.

A LOCOMOTIVE STRUCK A REPAIR GANG June 29 on the Baltimore & Ohio R. R. at a trestle near the North Ave. bridge at Baltimore, Md. The gang of 13 men were at work laying a timber guard rail on one of the four tracks across the trestle. The trestle is at one end of a sharp curve and the approaching locomotive was hidden from the workmen by a freight train on an inner track. Only three of the men were aware of their danger in time to jump from the track; five of the others were killed and five badly wounded.

A LUMBER YARD FIRE AT ARNPRIOR, ONT., July 4-5, destroyed about $4,000,000 worth of lumber.

THE WHITE STAR LINER "BALTIC" collided with the oil ship "Standard" July 2, off the Atlantic coast near New York City. A large hole was torn in the "Baltic's" bow, but she was able to reach port at New York with little difficulty.

A DRAWBRIDGE ACCIDENT occurred at Michigan City, Ind., on June 24, when the passenger steamer "United States" struck a closed bridge over the river. The turntable was displaced, so that the bridge could not be opened.

A DEEP TUNNEL UNDER NEW YORK CITY, projected by the Board of Water Supply at an estimated cost of some $25,000,000, has been approved by the Board of Estimate and Apportionment of the city named. The tunnel will extend beneath a portion of the Borough of Manhattan, the East River, and a portion of the Boroughs of Brooklyn and Queens (see Eng. News, Dec. 9, 1909, page 652, and June 2, 1910, page 635).

THE SAG OR CALUMET CHANNEL, to connect the Calumet River with the main channel of the Sanitary District of Chicago, has been advanced one step towards construction by a permit issued by the Secretary of War on June 30, authorizing the District to construct such a channel. The controversy over this channel has been stated very clearly in our issues of June 16, 1910, and Nov. 18, 1909. Under the recent permit the existing flow allowable from Lake Michigan may be distributed between the Chicago River and the Calumet River. This permission in no way affects (or is to be used in) the friendly suit now pending in the U. S. Circuit Court (northern district of Illinois), brought by the United States against the Sanitary District of Chicago to determine the right of the District to divert from Lake Michigan for sanitary purposes an amount of water in excess of that now being diverted without first having obtained a permit from the Secretary of War. The immediate work proposed by the District is the construction of a channel about 17½ miles long, between Sag and the Calumet River, having a normal flow or capacity of 2,000 cu. ft. per sec., with regulating works at Blue Island. The proposed right-of-way, however, has been laid out for a future capacity of 4,000 cu. ft. per sec. The route has been surveyed and the right-of-way is being staked out; construction is contemplated as soon as the right-of-way can be acquired. Mr. G. M. Wisner, M. Am. Soc. C. E., is Chief Engineer of the Sanitary District.

A SEWAGE PURIFICATION WORKS FOR A SMALL portion of Philadelphia has been planned under the direction of Mr. George S. Webster, M. Am. Soc. C. E., Chief Engineer of the Bureau of Surveys, and Mr. Geo. E. Datesman, M. Am. Soc. C. E., Principal Assistant Engineer, and bids for the plant are now being asked. The plant will be known as the Pennypack Creek Sewage Disposal Works, and is estimated to cost $150,000. It will serve the Holmesburg district, near the large Torresdale water filtration works on the Delaware River. Its design is based, in part, on studies made at the sewage experiment station operated by the city at Spring Garden and Fairmount Park. We give an outline of the proposed works, kindly sent to us by Mr. Webster, as follows:

The sewage is collected from the combined system emptying into Pennypack Creek, by means of an interceptor, carried to a pumping station of ornamental design, planted about with shrubs and trees; thence is passed through a force main to the disposal works situated about 3,000 ft. away from the pumping station. The disposal works proper consists of reinforced-concrete sedimentation tanks of the Emscher type. The effluents from these tanks will pass into a constant-head tank, thence by means of a mechanical distributing device through nozzles on to percolating filters about one acre in extent. The effluents from these filters will be passed into a final sedimentation basin, a portion of which will be given over to disinfection with hypochlorite of lime. The final effluent will flow into Pennypack Creek near its junction with the Delaware River. The sludge from the sedimentation tanks will be run upon a prepared sludge lagoon and after expelling the moisture will be removed and either consumed or spread upon land.

The $20,000,000 U. S. RECLAMATION SERVICE LOAN Act passed by Congress just before adjournment limits the use of its proceeds to the completion of projects already under construction and provides that none of the money

shall be expended upon any existing project until it shall have been examined and reported upon by a board of engineer officers of the army, designated by the President of the United States, and until it shall be approved by the President as feasible and practicable and worthy of such expenditure; nor shall any portion of this appropriation be expended on any new project.

The $20,000,000 is to be regarded as a transfer or temporary loan to the Reclamation Fund, for the purpose of supplementing the proceeds from the sale of public lands which alone have made up the fund heretofore—except for repayments by settlers on irrigation projects. The transfer may be made from any unappropriated funds in the U. S. Treasury, or in lieu therefore certificates bearing not over 3% interest, redeemable after three years and in any event not running more than five years, are authorized. These certificates are to be in denominations of $50 or multiples thereof open to subscription by any citizen of the United States.

The act carries three riders: (1) Hereafter no irrigation project under the original act of June 17, 1902, "shall be begun unless and until the same shall have been recommended by the Secretary of the Interior and approved by direct order of the President of the United States. (2) No lands reserved for irrigation purposes shall hereafter be entered on "until the Secretary of the Interior shall have established the unit of acreage and fixed the water charges and the date when the water can be applied and made public announcement of the same." (3) Sec. 9 of the original act is repealed. That section virtually required the Reclamation Fund to be distributed among the various states from which it originated.

The board of army engineers called for by the portion of the act already quoted has just been named by President Taft, as follows: Lieut.-Col. John Biddle, Chairman; Lieut.-Col. William C. Langfitt, Maj. William W. Harts, Charles W. Kutz and Harry Burgess.

THE TYPHOID FEVER SITUATION AT MILWAUKEE, Wis., had improved by the end of June, according to information given to this journal by Dr. W. C. Rucker, Commissioner of Health. For the week ending June 25, there were 47 new cases and nine deaths from typhoid, which was a material improvement over some previous weekly reports. For June 25 and 26 combined, 18 cases and no deaths were reported, and for the two following days a total of only eight cases and three deaths. In response to an inquiry from this journal, Mr. Charles J. Poetsch, M. Am. Soc. C. E., City Engineer of Milwaukee, stated "a very temporary" hypochlorite plant for disinfecting the water-supply was put in operation on June 21. By June 30 this plant had been superseded by another, and Mr. Poetsch wrote "it is the intention later on to make the sterilization plant a permanent one." In a report to the City Council, dated June 20, 1910, Mr. Poetsch stated that the lake water which forms the city supply enters the submerged intake at a point 46 ft. below the lake level (instead of 60 ft. as stated on p. 763 of our issue of July 7). Mr. Poetsch referred to engineering studies made by Messrs. Benzenberg, Whitman, Davis and Fiad at the time when the location of the intake was decided upon. These engineers concluded that, taking into account the fact that the intake was 3½ miles in a northeasterly direction from the mouth of the river (where the sewage of the city enters the lake), and also taking into account the fact that the general current was in an opposite direction and that the river water was highly diluted by the flushing tunnel, there was little or no danger of contamination of the water-supply. Mr. Poetsch also stated in his recent report that very little suspicion had been cast on the water-supply until the recent outbreak of typhoid, and added that although the water-supply was blamed for this outbreak, he was not able to tell whether that blame was rightly or wrongly placed. He was of the opinion that it was not advisable to extend the intake further into the lake, both on account of difficulty of construction in deeper water (60 ft. at the crib) and because of loss of head and decreased capacity which would result from an extension. He also stated that the present intake has a capacity of 85,000,000 gals. per day and that before the pumpage reached that limit, it would be necessary to build another intake and pumping station. Finally, he recommended awaiting results of the operation of the hypochlorite disinfecting plant before coming to any further conclusion in the matter.

Reverting again to the letter from Dr. Rucker, we quote as follows:

The chlorination system has now been in operation for several days and is believed to be fairly efficient. It may be stated that it is not the opinion of this office that the pollution of the water is constant. The distance from the sewage outfall to the water intake is something like 3¼ miles, and the general current of the lake on this side is toward the south. Inasmuch as the sewage outfall is to the south of the intake, it is evident that under ordinary conditions pollution does not occur. When, however, we have very great storms, it is very easy to imagine that sewage might be rapidly carried to the intake. In fact, Major Judson of the U. S. Engineer Corps has reported that there are no dependable currents in Lake Michigan, and that they may be very greatly influenced by strong winds. Altogether conditions look very favorable now.

AN 800,000-LB. SCREW-OPERATED TESTING machine was completed recently by the Riehlé Bros. Testing Machine Co. for Lehigh University. It was tested at the makers' works in Philadelphia on June 20, and is now being installed at South Bethlehem, Pa. Prof. F. P. McKibben is in charge of the Civil Engineering Department at Lehigh.

THE APPALACHIAN FOREST BILL, which has been before Congress for so many years, passed the House by a vote of 130 to 111 before its recent adjournment. Action by the Senate was postponed until February, 1911. The bill provides for or makes possible national forest reserves in the White Mountains and in the Southern Appalachians.

Personals.

Mr. R. H. Howard, Engineer of Maintenance of Way for the Chicago & Eastern Illinois R. R., has resigned and will take a position with an eastern railway.

Mr. Charles L. Ewing has resigned his position as General Superintendent of the Illinois Central R. R. at Chicago, Ill., and will be succeeded by Mr. Robert W. Baxter.

Mr. John J. McLaughlin, M. Am. Soc. C. E., has resigned his position as Consulting Engineer of the Borough of Queens, New York City. His resignation is ascribed to the growth of his private practice.

Mr. B. M. Hall, M. Am. Soc. C. E. and Am. Inst. M. E., has resigned his position as Chief Engineer of the Porto Rico Irrigation Service and will return to Atlanta, Ga., to resume his practice as a consulting engineer.

Mr. George R. Putnam, M. Am. Soc. C. E., Chairman of the Chart Board of the U. S. Coast and Geodetic Survey, Washington, D. C., has been appointed Commissioner of the newly-created Bureau of Lighthouses of the Department of Commerce and Labor.

Mr. George H. Campbell, who has been succeeded by Mr. C. C. F. Bent as General Superintendent of the New York division of the Baltimore & Ohio R. R., has been appointed Assistant to the President in addition to the present Assistant, Mr. George M. Shriner.

Mr. W. H. Sanders, M. Am. Soc. C. E., of Los Angeles, Cal., Consulting Engineer, U. S. Reclamation Service for the past seven years, has been placed on a per diem basis and is now available for general consulting work in irrigation and water-power development.

Mr. F. E. Trask, M. Am. Soc. C. E., of Los Angeles, Cal., who, as noted in our issue of June 16, was recently appointed Chief Engineer of the Arrowhead Reservoir & Power Co., San Bernardino, Cal., is continuing at the same time his general practice as a consulting engineer.

Mr. John G. Walber, General Superintendent of Transportation of the Baltimore & Ohio R. R., has been promoted to be Assistant General Manager. He will be succeeded in the former position by Mr. C. W. Galloway, recently Superintendent of Transportation. The last-named position has been abolished.

Mr. N. R. McLure, Assoc. M. Am. Soc. C. E., recently Assistant Engineer of the Phoenix Bridge Co., at Phoenixville, Pa., has been made Resident Engineer of the same company with office at 527 Pierce Bldg., St. Louis, Mo. He will take the place of Mr. O. J. West, Assoc. M. Am. Soc. C. E., of Chicago, Ill., who has resigned to take up other work.

Mr. J. W. Frazier, M. Am. Soc. C. E., and Mr. J. H. Fox, consulting engineers, of Cleveland, Ohio, have dissolved their partnership under the firm name of Frazier & Fox. Mr. Fox will become Chief Engineer of the Pittsburg Plate Glass Co. Mr. Frazier will continue the engineering work of the firm in Cleveland under the name of the J. W. Frazier Co., with offices in the Rockefeller Bldg.

Brig.-Gen. Wm. L. Marshall, Corps of Engineers, U. S. A., retired, has been appointed Consulting Engineer to the Secretary of the Interior, to act in connection with reclamation projects. This newly-created position involves a salary of $7,500 a year. Brig.-Gen. Marshall will act only in an advisory capacity, it is understood, and will not have supervision or control over the operations of the Reclamation Service.

Mr. Samuel A. Greeley, Jun. Am. Soc. C. E., has been appointed Superintendent of the new refuse incineration plant of Milwaukee, Wis. Mr. Greeley, who is a graduate of the Massachusetts Institute of Technology, was in charge of the construction of the plant as Resident Engineer for Hering & Fuller, of New York City. He stood highest (97.3%) in the civil service examination held by the city of Milwaukee for the Superintendency.

Obituary.

Benjamin F. Wood, Chief Engineer, U. S. N., retired, died July 3 at his home in Mount Vernon, N. Y. He entered the Navy in July, 1861, as a third assistant engineer and became a chief engineer with the rank of Commander in 1883. He was retired in October, 1892.

Edmund D. North, M. Am. Inst. M. E., died June 22 at Mexico City from injuries received the preceding day at Angangueo, Mex. Mr. North was 31 years old and while making an examination of an old silver mine was a graduate of the mining engineering course at Stanford University.

Elbridge Leonard Brown, a civil engineer, of Brockton, Mass., died at that place June 27, aged 63 years. He was born in North Bridgewater, Mass., and was educated at the Massachusetts Institute of Technology. He was the first city engineer of Brockton, having been elected in 1885 for a two-year term.

Engineering Societies.

COMING MEETINGS.

AMERICAN CHEMICAL SOCIETY.
July 12-16. Annual meeting at San Francisco, Cal. Secy., Charles L. Parsons, Durham, N. H.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 26-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
July 26-29. Joint meeting with the British Institution of Mechanical Engineers at Birmingham and London, England. Secy., Calvin W. Rice, 29 West 39th St., New York City.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 16-19. Annual convention at Niagara Falls, Canada. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
Aug. 23-26. Annual convention at St. Paul, Minn. Secy., John MacVicar, Des Moines, Iowa.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 5-9. Annual meeting at Milwaukee, Wis. Secy., W. C. Woodward, Washington, D. C.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 6-8. Annual meeting at Thousand Islands, N. Y. Asst. Secy., Walter Neumuller, 55 Duane St., New York City.

MICHIGAN GAS ASSOCIATION.
Sept. 8-12. Annual meeting on board steamer sailing from Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 13-16. Annual convention at St. Louis, Mo. Secy., A. P. Dane, Reading, Mass.

LEAGUE OF AMERICAN MUNICIPALITIES.—Subjects to be discussed at the 14th annual convention at St. Paul, Minn., Aug. 23-26, will include the commission form of government, home rule for cities and other topics relating to city government, and street pavement maintenance. Among those who are to speak on the paving problem is Mr. Frank T. Fowler, Superintendent of Streets of Chicago, Ill.

NATIONAL CONSERVATION CONGRESS.—The second congress will be held at St. Paul, Minn., Sept. 6-9. The objects of the congress are:

(1) To provide for discussion of the resources of the United States as the foundation for the prosperity of the people.
(2) To furnish definite information concerning the resources and their development, use and preservation.
(3) To afford an agency through which the people of the country may frame policies and principles affecting the conservation and utilization of their resources, to be put into effect by their representatives in State and Federal Governments.

Delegates to the congress are appointed by mayors of cities, boards of county commissioners, national societies, universities, etc.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—The attendance at the 18th annual meeting, held in Madison, Wis., June 23-26, was 149, exceeding that of any previous meeting of this society. The address of welcome was delivered by President Chas. R. Van Hise, of the University of Wisconsin. President Van Hise spoke especially of the relation of engineering education to other branches of educational work and of the necessity of cultural studies in the education of the engineer.

The Secretary announced an increase of 101 in the membership since the last meeting, making the total membership now more than 800. He reported evidence of increasing interest and activity among the members in behalf of the society's work, especially noticeable among those members who are practicing engineers. The treasurer's report showed a cash balance on hand of about $340, with liabilities of about $300 and assets, in the form of volumes of proceedings and unpaid dues, of $3,535.

The first paper read, "Inspection Trips for Technical Students," by Prof. Geo. C. Shaad, of the University of Kansas, outlined the advantages of such trips and the proper methods for conducting them. A paper on "The Teaching of Judgment," by Edward J. Kunze, of the University of Wisconsin, maintained that a special effort should be made to teach "judgment" to technical students during the college course. Judgment, he said, might be acquired through one's own experience or from the observation of the experience of others. The experience of others can be observed or studied during the college course for a considerable range of subjects. Judgment results from critical comparison and may be developed in the student by having him make classified collections, for example, of pictures and descriptions of different types of various machine parts, with tabulated data of allowable working stresses.

A symposium on "Cooperative Work for the Railroad Commission and Tax Commission of Wisconsin" was made up of three brief papers, by Professors W. D. Pence, J. G. D. Mack and C. P. Burgess, of the University of Wisconsin. Prof. Pence's paper was historical and descriptive, Prof. Mack's took up mechanical features and Prof. Burgess the gas and electric service.

Dr. Geo. H. Shepard, of Syracuse University, presented a very full and interesting summary of methods used in the German technical universities, and a comparison with American methods.

The Report of the Committee on Entrance Requirements, after some discussion, was adopted as read. The report presented a list of the subjects among which are to be found the entrance requirements for engineering colleges, and then proceeded to define in considerable detail the requirements of the courses of study in each of these subjects, which are classified under the general heads of mathematics, science, language, history and manual training.

The report of the Committee on Engineering Degrees was read by the Chairman, Prof. W. F. M. Goss, and after considerable and heated discussion by the members, it was approved and accepted, practically as presented. This report gives the results of an investigation, made through circular letters sent out to the engineering schools of the country, of present practice and opinions regarding the granting of engineering degrees. Replies were obtained from 92 institutions. Of these, 64 considered uniformity in the granting of degrees to be desirable; and 40 out of the 64 would be willing to conform to a standard agreed upon by a majority of the colleges, while 20 others state that they would "favorably" conform. The report concludes with the recommendation of a system of engineering degrees to be adopted as a standard.

The report of the Committee on Technical Books for Libraries was accepted, after which a paper was presented on "The Development of the Engineering College of the University of Wisconsin," by Dean Frederick E. Turneaure.

The report of the Committee on Engineering Mathematics was presented and was followed by a prolonged discussion. In the report, the committee presents a synopsis of the fundamental mathematical principles and methods which should constitute the minimum mathematical equipment of the engineering student. In the discussion, particular interest was shown in the subject of instruction in calculus. It seemed to be the general opinion that present methods of teaching calculus might be greatly improved. The discussion indicated that the trouble did not lie in the student's failure to master the subject as taught but in the inadequacy of the teaching along the line of practical application. It was pretty well agreed that better results would follow if the student solved more problems which call for the adaptation of the calculus methods to conditions met with in practice. Two methods of obtaining this result were suggested. First, requiring the solution of more practical problems in connection with the teaching of calculus; and second, using the calculus more freely in the solution of problems in mechanics and the more advanced subjects. Teachers of pure mathematics who took part in the discussion insisted that a thorough understanding of the underlying principles should not be sacrificed in this effort to teach more of the practical side. The discussion, of which the above is only a brief outline, can hardly fail to be of value in promoting a better understanding between departments whose work is so closely allied.

The presidential address, by Prof. Henry S. Munroe, of Columbia University, was not delivered until the third session of the convention. It was on "Efficiency in Engineering Education," and was followed by a symposium on the same subject. In addition to about 20 brief contributed papers, the symposium included one of several thousand words on "System and Efficiency in Technical Instruction," (read by title only) by Prof. S. E. Slocum, of the University of Cincinnati. The session was concluded with a paper on "Inspection Trips of Ohio State University Students," by Prof. W. T. Magruder.

After a visit, on Friday afternoon, to the various laboratories of the University of Wisconsin, the members were transported to the Golf Club, where an informal supper was served. Following the supper, President Van Hise, of the University of Wisconsin, delivered an address on "The Conservation of Our National Resources." The party then returned to Madison by boat.

The first paper of the Saturday morning session was on "Recent Progress in Cooperative Technical Education," by Dean Herman Schneider, of the College of Engineering, University of Cincinnati. Other papers presented, including those read only by title were as follows: "Clearness and Accuracy in Composition," J. J. Clark, International Correspondence Schools; "Character Training," J. P. Jackson, Pennsylvania State College; "Technical Education in Germany," Frank Koester, New York City; "Technical Education in China," W. H. Adams, Imperial Pei Yang University, Tientsin, China; "Harvard Plan of Graduate Instruction," W. C. Sabine, Harvard University.

Mr. Koester's paper gave a concise account of the German technical educational system and pointed out that American educators might profit by a closer study of European methods. He attributed to Germany's educational system much of the credit for her highly developed industrial activity. Mr. Adams' paper was confined to a description of the engineering work at the Pei-Yang University. This school was first organized in 1895. At the present time all instruction is given in the English language and much of the laboratory and shop equipment is of American make. The equipment compares favorably with that of engineering colleges in this country. The average age of freshmen is 24 or 25 years. Three-year courses are now given in civil and mining engineering.

An important step was taken in the advancement of the society's interests in beginning the publication of a "Bulletin," the first number of which was distributed among the members as a sample of what the proposed "Bulletin" would be like. After consideration by the Executive Council, it was decided that the "Bulletin" be issued monthly.

Officers for the ensuing year were elected as follows: President, Arthur N. Talbot, University of Illinois; Vice-Presidents, Wm. Kent, Montclair, N. J., and Milo S. Ketchum, University of Colorado; Treasurer, W. O. Wiley, New York City; Secretary, Henry H. Norris, Cornell University, Ithaca, N. Y.